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PROCEDURES FOR TESTING PASTEURIZATION EQUIPMENT

Public Health Service
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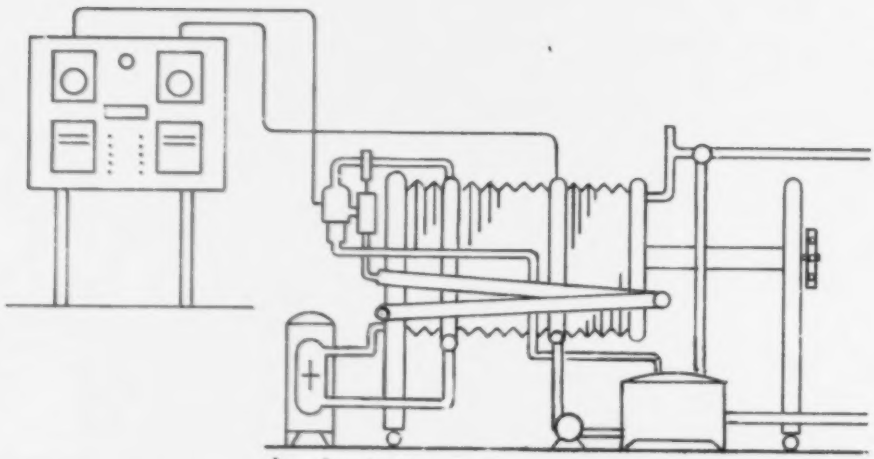

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

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Procedures for
TESTING
PASTEURIZATION
EQUIPMENT

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

Division of Environmental Engineering and Food Protection
Milk and Food Branch
Washington, D. C. 20201

I

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II

PREFACE

The procedures and guidelines outlined in this manual are based on the requirements of the *Grade "A" Pasteurized Milk Ordinance—1965 Recommendations of the United States Public Health Service* (PHS Publication No. 229). This manual is a revision of an earlier and similar publication, "Procedures for Testing Pasteurization Equipment," (PHS Publication No. 731) prepared by Mr. Hugh E. Eagan, Training Consultant of the Public Health Service, Communicable Disease Center, Atlanta, Georgia. It is intended to provide a ready reference for the milk sanitarian and for trainees on the tests necessary to assure that the controls and other design features of processing equipment and the method of operation are such that effective pasteurization of the product will invariably be accomplished. Pasteurization is the only single public health measure known which, if properly applied, will effectively prevent all milk-borne disease. Effective control of the pasteurization process is, therefore, of paramount importance in any milk sanitation program. This cannot be accomplished without a clear understanding of the functioning and complexities of modern pasteurization equipment, including the performance of the tests herein described to assure that proper time-temperature-pressure relationships are safeguarded so that effective pasteurization will result.

The test numbers in this manual correspond to the test numbers on Form PHS-723-2 (Rev. 1-65) (Fig. 3). Note that this form summarizes the individual tests, the specified frequencies for each, the corresponding milk ordinance page reference number, and calls for columnar entries to indicate the tests made and the identity of the equipment tested, as well as the name of the milk plant, the date, and the name of the sanitarian who performed the tests. When tests are made, it is important that this form be carefully completed and placed on file. Such records are not only indicative of effective control of the pasteurization process, but are also needed for review when periodic State Milk Sanitation Rating Surveys are made of the milk control program.

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Part I—TESTS OF BATCH PASTEURIZATION EQUIPMENT

The *Grade "A" Pasteurized Milk Ordinance—1965 Recommendations of the United States Public Health Service* outlines certain tests to be made at specified frequencies on pasteurization equipment.

It is important to determine, by means of the tests, and by periodic review of the equipment, methods of operation, and plant records that the pasteurization process is being conducted effectively so as to assure the safety of the product. The milk control authority should arrange that tests be made on each piece of equipment at the frequencies specified in the milk ordinance.

EQUIPMENT NECESSARY FOR TESTS ON BATCH PASTEURIZERS

1 AGITATORS—Long handled milk agitator available through dairy equipment supply firms.

2 CONTAINERS—The 10-gallon milk cans can usually be borrowed from the milk plant operator for the tests.

3 STOPWATCH

Type—Pocket type, open face, hand indicating fractional seconds
Accuracy—Accurate to one-fifth of a second
Scale—Divisions of not over two-tenths of a second
Crown—Depression of crown starts, stops, and resets to zero

4 TEST THERMOMETER

Type—Mercury actuated; readily cleanable; plain front; enameled back; top finish with glass ring; length 12 inches; standardized for 4 inch immersion; immersion point to be etched on stem; contraction chamber to be of narrow type immediately above bulb, not over one inch long; mercury to stand in contraction chamber at 32°F.

SCALE RANGE—142°F to 168°F with extension of scale on either side permitted; 142°F point to be not less than one inch above immersion line. Protected against damage. Temperature represented by smallest scale division −0.2°F. Number of degrees per inch of scale—not more than six.

ACCURACY—With 0.2°F, plus or minus, through specified scale range. The accuracy shall be checked against a thermometer which has been tested for accuracy by the National Bureau of Standards.

CARRYING CASE—Felt-lined metal.

Bulb—Corning normal or equally suitable thermometric glass. (Taylor Instrument Company, Rochester, New York, Catalogue No. 21894, or equivalent)[1]

TEST NO. 1—INDICATING THERMOMETERS—TEMPERATURE ACCURACY

REASON—To assure that all indicating thermometers are in good repair and are accurate.

APPLICATION—To all indicating thermometers used for measurement of product temperatures during pasteurization, including airspace thermometers.

FREQUENCY—Upon installation and quarterly thereafter.

CRITERIA—Within 0.5°F for pasteurization and 1.0°F for airspace thermometers, plus or minus, within the specified scale range.

TEST PROCEDURE—Prepare 10 gallons of water in a milk can by heating the water to approximately 145°F with a steam hose. Keep the water well agitated and remove the steam hose before making the test. One person should use a manual agitator to stir the water constantly throughout the test with a vigorous rotary motion while another lowers the indicating and the test thermometers into the water so that the bulb of the former is fully submerged and the latter submerged at least four inches to the etched immersion point. Check and record the readings of the two thermometers. Repeat the test and take a second set of readings. The indicating thermometer and the test thermometer should check within 0.5°F of each other, or within 1°F for airspace thermometers, if not, have the plant operator adjust the scale plates on the indicating thermometer. This is done by removing the face plate and loosening the set screws on the scale plate. By sliding the plate up or down, adjust so the reading agrees with the test thermometer. Tighten screws securely and replace the face plate. Retest the thermometer after adjustment. When silica gel is employed as a moisture absorbing agent, it should be

[1] Trade names are used throughout as a convenient means of identifying sources of the test equipment under discussion. This should not be considered as constituting an endorsement or recommendation of any item listed. Also, there is no intention to imply that test equipment items from various sources are necessarily comparable to each other in durability or performance, nor that they meet all claims of the manufacturer.

thoroughly dried and replaced each time the protective glass cylinder of the thermometer is removed. On reassembly the glass cylinder should be carefully reseated so as to exclude moisture.

Do not perform the test if the mercury column has been split or the capillary tube has been damaged, in which case the thermometer should be returned to the manufacturer for repair or replacement.

TEST NO. 2—RECORDING THERMOMETERS—TEMPERATURE ACCURACY

REASON—To assure the thermometer's capability of recording correct temperature after being subjected to a wide range and sudden fluctuation in temperature.

APPLICATION—To all recording thermometers used to record product temperatures during pasteurization.

FREQUENCY—Upon installation, at least quarterly thereafter, and whenever recording pen-arm setting requires frequent adjustment.

CRITERIA—Within 1°F, plus or minus, in specified scale range.

TEST PROCEDURE—The test is a determination of whether or not the temperature recording pen-arm will return to within 1°F of its previous setting after the sensor bulb is exposed to boiling water and melting ice. The steps are as follows:

1 Adjust the recording pen to read exactly in agreement with the previously tested indicating thermometer (Test No. 1) while the sensor bulb of the recorder and the indicating thermometer bulb are immersed in a can of water previously heated to about 145°F with the water manually agitated continuously for about five minutes so that both temperature readings may stabilize. If desired, this adjustment may be made with both thermometer bulbs immersed in water for five minutes at about 145°F in the pasteurization vat with the agitator in operation.

2 Fill a can with water heated to the boiling point with a steam hose, keeping the hose in the can with the steam valve just open. Fill another can with melting ice. Place both cans within working distance of the recording thermometer bulb.

3 Immerse bulb of recorder in the boiling water for five minutes, followed immediately by immersion of the bulb in the melting ice for five minutes.

4 Place bulb of recorder back in the can or pasteurizer with water at about 145°F and agitate continuously for five minutes

for stabilization of readings, then determine whether the recorder reading is within 1°F of the reading of the indicating thermometer. If the recorder fails to meet this test, it should be returned to the manufacturer for repair.

TEST NO. 3—RECORDING THERMOMETERS—TIME ACCURACY

REASON—If the recorder chart rotates at too high a speed, the recorder holding time will be less than the true elapsed time.

APPLICATION—To all recording thermometers used to record time of pasteurization.

FREQUENCY—Upon installation, and at least quarterly thereafter.

CRITERIA—The recorded time of pasteurization shall not exceed the true elapsed time.

TEST PROCEDURE—A comparison is made of the recorded time over a period of not less than 30 minutes with a watch of known accuracy and time divisions not to exceed one minute. First, see that the recording pen is clean and free flowing, leaving a mark not over one-fortieth of an inch wide, and that the paper chart is clean and dry and appropriate to the recorder Inscribe a reference mark at the pen point on the recorder chart at the start of the holding period and record the time. At the end of 30 minutes by the watch, inscribe a second reference mark at the pen point position on the chart. With a pair of dividers or a linear scale, measure the distance between the two reference marks and compare with the time scale divisions on the record chart at the same temperature. For electric clocks remove the face plate and compare the cycle specification on the face plate with that of the power source in use. If the recorded time is incorrect, the plant operator should adjust the clock, if adjustment can be made, and retests should be made until the readings coincide; otherwise, the clock should be returned to the manufacturer for repair. Enter the findings on the chart and initial.

TEST NO. 4—RECORDING THERMOMETERS—CHECK AGAINST INDICATING THERMOMETER

REASON—The recording thermometer is a sensitive instrument which requires periodic adjustment so as to provide continuously an accurate record of the time-temperature relationship of pasteurization.

APPLICATION—To all recording thermometers used to record product temperatures during pasteurization.

FREQUENCY—Initially and at least quarterly by the milk control authority; daily by the plant operator.

CRITERIA—Recording thermometer shall not read higher than the corresponding indicating thermometer.

TEST PROCEDURE—While product is at a stabilized pasteurization temperature, read the indicating thermometer. Immediately inscribe on the recording-thermometer chart a line intersecting the recorded temperature arc at the pen location; record on the chart the indicating thermometer reading, and initial. If the recording thermometer should read higher than the indicating thermometer, the pen should be adjusted by the plant operator.

TEST NO. 6—LEAK PROTECTOR VALVES

REASON—To determine whether inlet and outlet valves on batch pasteurizers actually prevent leakage past the valve seat in any closed position. If inlet valves leak, raw product may enter the pasteurizers during the holding period, and thus be underheld. If outlet valves leak, incompletely pasteurized product may enter and contaminate the outlet piping.

APPLICATION—To all pasteurizer inlet and outlet valves.

FREQUENCY—Initially, and at least quarterly thereafter.

CRITERIA—No leakage of product past the valve seat in any closed position.

TEST PROCEDURE—During normal operation, while product pressure is exerted against the valve inlet, fully close the valve and disconnect the outlet piping. (Caution: Care must be taken to avoid contamination of the valves or the piping.) Observe whether or not any product is leaking past the valve seat into the valve outlet. In the case of plug type valves, turn the valve to the just closed position, and examine for leakage into the valve outlet. Reconnect the outlet piping after giving bactericidal treatment if indicated. Record identity of the valve and findings. If leakage past the valve seat should occur in any closed position, the valve plug should be reground, replaced, or other necessary steps taken to prevent leakage.

Part II—TESTS OF HIGH-TEMPERATURE SHORT-TIME PASTEURIZATION EQUIPMENT

The *Grade "A" Pasteurized Milk Ordinance—1965 Recommendations of the United States Public Health Service* outlines certain tests to be made at specified frequencies on HTST pasteurization equipment.

Test numbers used in this part of the manual also correspond to the test numbers on form PHS-723-2 (Rev. 1-65), (Fig. 3), as mentioned in the preface. The milk control authority should arrange that tests be made on each piece of equipment at the frequencies specified in the *Milk Ordinance*. This part of the manual presents a logical working sequence for the series of tests.

EQUIPMENT NECESSARY FOR TESTS ON HTST PASTEURIZATION UNITS

In addition to the agitators, containers, stopwatch, and test thermometer, as specified in the test equipment needs under Part I of this manual (page one), the following test equipment is also needed for tests of HTST pasteurizers:

1 Electrical conductivity measuring devices and accessories.

TYPE—Wheatstone Bridge, galvanometer, milliammeter; manual or automatic; capable of detecting change produced by 10 ppm of sodium chloride in water of 100 ppm hardness. Automatic instruments with electric clock, time divisions not more than two-tenths of a second.

ELECTRODES—Two standard electrodes, one with a syringe connection.

SYRINGE—50 ml or 250 ml veterinary, equipped to fit syringe connection on the electrode.

SALT (sodium chloride)—Also container for mixing salt solution.

ADAPTERS—To fit electrodes into all sizes of 3A fittings in the milk control jurisdiction.

(Sources of measuring devices and accessories—a. Wheatstone Bridge—solu-bridge model RD-40, manual and solu-bridge model RT-3, automatic, from the Industrial Instrument Company, 89 Commerce Road, Cedar Grove, N.J. or the Suminite Electronic Company, 407 S. Dearborn, Chicago, Illinois; b. Galvanometer—Taunt suspension, model B with proper shunt, Fisher Scientific Company, 711-723 Forbes St., Pittsburgh, Pa.; and c. Milliammeter—D.C. model AEC 252, Type DO-41-FSIM, available from Wisner Manufacturing Company, 122 Hudson St., New York 13, N.Y. or Sidney P. Foster, 104 Schenck Blvd., Floral Park, N.J.)[2]

2 Gage, vacuum and pressure type—The combined vacuum-pressure gage known as the Vogt Freezer Gage is of sanitary construction.[3] It is of a two-inch sanitary pipe size, but with sanitary adapters it may be used on all sizes of pipe. May be obtained through most milk plant equipment supply firms.

3 Pneumatic testing device and accessories, as hereinafter detailed under Test No. 9.

TEST NO. 1—INDICATING THERMOMETERS ON HTST PIPELINES—TEMPERATURE ACCURACY

REASON—To assure that all indicating thermometers are in good repair and are accurate.

APPLICATION—To all indicating thermometers located on pipelines and used for measurement of product temperatures during pasteurization.

FREQUENCY—Upon installation and quarterly thereafter.

CRITERIA—Within 0.5°F (plus or minus, within the specified scale range.

TEST PROCEDURE—Prepare 10 gallons of water in a milk can by heating the water to approximately 161°F with a steam hose. Keep the water well agitated and remove the steam hose before making the test. One person should use a manual agitator to stir the water constantly throughout the test with a vigorous rotary motion while another lowers the indicating and the test thermometers into the water so that the bulb of the former is fully submerged and the latter submerged at least four inches to the etched immersion point. Check and record the readings of the two thermometers. Repeat the test and take a second set of readings. The indicating thermometer and the test thermometer should check within 0.5°F of each other. If not, have the

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[2] and [3]
See footnote 1, page 2.

plant operator adjust the scale plates on the indicating thermometer. This is done by removing the face plate and loosening the set screws on the scale plate. By sliding the plate up or down, adjust so the reading agrees with the test thermometer. Tighten screws securely and replace the face plate. Retest the thermometer after adjustment. When silica gel is employed as a moisture absorbing agent, it should be thoroughly dried and replaced each time the protective glass cylinder of the thermometer is removed. On reassembly, the glass cylinder should be carefully reseated so as to exclude moisture.

Do not perform the test if the mercury column has been split or the capillary tube has been damaged, in which case the thermometer should be returned to the manufacturer for repair or replacement.

TEST NO. 7—INDICATING THERMOMETERS ON PIPELINES—THERMOMETRIC RESPONSE

REASON—The indicating thermometer must be capable of responding rapidly to changes in product temperature in order to provide accurate readings.

APPLICATION—To all indicating thermometers located on product pipelines and used for determination of product temperatures during pasteurization.

FREQUENCY—Initially, and quarterly thereafter.

CRITERIA—Four seconds response under the specified test conditions.

TEST PROCEDURE—This test involves measuring with a stopwatch the time required for the indicating thermometer to increase 12°F through a specified temperature range while immersed in a water bath of specified temperature. The temperature of the water bath should be at least 19°F higher than the minimum scale reading on the indicating thermometer and also higher than the maximum pasteurization temperature for which the thermometer is used. The 12°F temperature range to be timed is from 19°F below the water bath temperature to 7°F below the bath temperature. For example, on a thermometer with a scale range 150°F–175°F, used for pasteurization at both 161°F and 166°F, a water bath temperature of 170°F could be used. The 12°F temperature range to be timed would then be from 151°F to 163°F. Proceed as follows:

Prepare ten gallons of water in a milk can by heating the water with a steam hose to the test temperature of 170°F with the thermometer bulb in the water. Keep the water well agitated

and remove the steam hose before making the test. One person should use a manual agitator to stir the water with a vigorous rotary motion constantly throughout the test, while another quickly removes the thermometer, immerses its bulb for a few seconds in a container of cool water, and then reinserts it to proper bulb immersion in the hot water. Start a stopwatch when the indicating thermometer reads 19°F below the selected water temperature and stop the watch when the reading reaches 7°F below the water temperature. The elapsed time should not exceed 4 seconds, if it does, the thermometer should be replaced or repaired. The time determination should begin within 15 seconds after the water is heated to the desired temperature, so that the water temperature does not cool significantly. If a delay occurs, reheat the water and repeat the test.

TEST NO. 4—RECORDING THERMOMETERS—CHECK AGAINST INDICATING THERMOMETER

REASON—The recorder-controller is a sensitive instrument which requires periodic adjustment so as to provide continuously an accurate record of the time-temperature relationship of pasteurization.

APPLICATION—To all recorder-controllers used to record product temperatures during pasteurization.

FREQUENCY—Initially, and at least quarterly by the milk control authority; daily by the plant operator.

CRITERIA—Recorder should not read higher than the corresponding indicating thermometer.

TEST PROCEDURE—While HTST pasteurizer is at a stabilized pasteurization temperature, read the indicating thermometer. Immediately inscribe on the recording-thermometer chart a line intersecting the recorded temperature arc at the pen location; record on the chart the indicating thermometer reading, and initial. If the recording thermometer should read higher than the indicating thermometer, the pen should be adjusted by the plant operator.

TEST NO. 2—RECORDING THERMOMETERS—TEMPERATURE ACCURACY

REASON—To assure the thermometer's capability of recording correct temperature after being subjected to a wide range and sudden fluctuation in temperature.

APPLICATION—To all recorder-controller thermometers used to record product temperatures during pasteurization.

FREQUENCY—Upon installation, at least quarterly thereafter, and whenever recording pen-arm setting requires frequent adjustment.

CRITERIA—Within 1°F, plus or minus, in specified scale range.

TEST PROCEDURE—The test is a determination of whether or not the temperature recording pen-arm will return to within 1°F of its previous setting after the sensor bulb is exposed to boiling water and melting ice. The steps are as follows:

1 Have the plant operator adjust the recording pen to read exactly in agreement with the previously tested indicating themometer (Test No. 1), while the sensor bulb of the recorder and the indicating thermometer bulb are immersed in a can of water previously heated to about 161°F, with the water manually agitated continuously for about five minutes so that both temperature readings may stabilize. If desired, this adjustment may be made with both thermometer bulbs in place in the HTST pasteurizer, after it has operated with water for about five minutes at or near the pasteurization temperature.

2 Fill a can with water heated to the boiling point with a steam hose, keeping the hose in the can with the steam valve just open. Fill another can with melting ice. Place both cans within working distance of the recording thermometer bulb.

3 Immerse bulb of recorder-controller in the boiling water for five minutes, followed immediately by immersion of the bulb in the melting ice for five minutes.

4 Place bulb of recorder-controller back in the can or pasteurizer with water at about 161°F and agitate or run pasteurizer continuously for five minutes for stabilization of readings, then determine whether the recorder reading is within 1°F of the reading of the indicating thermometer. If the recorder fails to meet this test, it should be returned to the manufacturer for repair.

TEST NO. 3—TEMPERATURE RECORDER—CONTROLLER —TIME ACCURACY

REASON—If the recorder chart rotates at too high a speed, the recorded length of operation will be less than the true elapsed time.

APPLICATION—To all temperature recorder-controllers used to record product temperatures during pasteurization.

FREQUENCY—Upon installation, and at least quarterly thereafter.

CRITERIA—The recorded length of operation shall not exceed the true elapsed time.

TEST PROCEDURE—A comparison is made of the recorded time over a period of not less than thirty minutes with a watch of known accuracy and time divisions not to exceed one minute. First, see that the recording pen is clean and free flowing, leaving a mark not over one-fortieth of an inch wide, and that the paper chart is clean and dry and appropriate to the recorder-controller. Then inscribe a reference mark at the pen point on the recorder chart and record the time; at the end of thirty minutes by the watch, inscribe a second reference mark at the pen point position on the chart. With a pair of dividers or a linear scale, measure the distance between the two reference marks and compare with the time scale divisions on the record chart at the same temperature. For electric clocks remove the face plate and compare cycle specification on the face plate with that of the power source in use. If the recorded time is incorrect, the plant operator should adjust the clock, if adjustment can be made, and retests should be made until the readings agree; otherwise, the clock should be returned to the manufacturer for repair. Enter the findings on the chart, and initial.

TEST NO. 10—MILK-FLOW CONTROLS—PRODUCT TEMPERATURE AT CUT-IN AND CUT-OUT

REASON—Precise setting of the cut-in and cut-out points on the recorder-controller is essential to assure that only properly pasteurized products pass into forward flow port of the flow-diversion valve.

APPLICATION—To all recorder-controllers used in connection with HTST pasteurizers.

FREQUENCY—Upon installation and quarterly thereafter by milk control authority; daily by the plant operator.

CRITERIA—No forward flow of product until pasteurization temperature has been reached. Product flow diverted before temperature drops below minimum for pasteurization.

TEST PROCEDURE—The test involves careful reading of the indicating thermometer at the instant forward flow starts (cut-in) and stops (cut-out). Proceed as follows:

1 Cut-in temperature—Operate the HTST unit in diverted flow either with product or with water with the recorder-controller

and indicating thermometer bulbs in place and with the heating medium controller set two or three degrees below the temperature normally required to establish forward-flow. After stabilization of the heating medium temperature at this point, have the plant operator gradually increase the heat so as to raise the product or water temperature at a rate not exceeding 1°F every 30 seconds. Observe the indicating thermometer reading at the moment forward flow begins. This can be done accurately and conveniently by watching the thermometer closely and continuously, and with a finger placed on the connecting key or valve stem of the flow-diversion valve so that the first motion of the valve movement can be detected. Observe that the frequency pen reading is synchronized with the recording pen on the same reference arc of the chart. Record the temperature of the cut-in point on the chart, and initial.

2 Cut-out temperature—After the cut-in temperature has been determined and while the product or water is slightly above the cut-out temperature and stabilized, have the operator reduce the heating medium temperature at a rate not exceeding 1°F every 30 seconds. Observe indicating thermometer reading at the moment forward flow stops, in a manner similar to that described for determining cut-in. Record the temperature of the cut-out point on the chart, and initial.

Should the reading be below the minimum pasteurization temperature, the cut-in and cut-out mechanism and/or the differential temperature mechanism should be adjusted to obtain proper cut-in and cut-out temperatures by repeated tests. When compliance is achieved, seal the controller mechanism.

TEST NO. 8—RECORDER-CONTROLLER—THERMOMETRIC RESPONSE

REASON—The recorder-controller must be capable of responding rapidly to changes in product temperature in order to provide continuously an accurate record of the pasteurization process.

APPLICATION—To all recorder-controllers used in connection with HTST pasteurizers.

FREQUENCY—Upon installation, and quarterly thereafter.

CRITERIA—Five seconds response, under the specified test conditions.

TEST PROCEDURE—This test involves measuring with a stopwatch the time interval between the instant when the recording thermometer reads 12°F below the cut-in temperature

and the moment of cut-in by the controller. This measurement is made when the sensing element is immersed in a rapidly agitated water bath maintained at exactly 7°F above the cut-in temperature. Proceed as follows:

1 Check, and if necessary, adjust the pen-arm setting of the recording thermometer in the proper reference arc and to agree with the indicating thermometer reading at the pasteurization temperature.

2 Determine the cut-in temperature of controller (Test No. 10) either while in normal operation or by using a water bath.

3 Remove sensing element and allow to cool to room temperature.

4 Heat water bath to exactly 7°F above the cut-in temperature while vigorously agitating water bath to insure uniform temperature.

5 Immerse recorder-controller bulb in water bath. Continue agitation during items 6, and 7, below.

6 Start stopwatch when the recording thermometer reaches a temperature of 12°F below the cut-in temperature. To facilitate timing, mark the chart at this temperature before beginning the test.

7 Stop the stopwatch when the controller cuts in.

8 Record thermometric response time. If this exceeds five seconds, the recorder-controller should be repaired.

TEST NO. 5—FLOW DIVERSION VALVE—PROPER ASSEMBLY AND FUNCTION

REASON—Proper operation of the flow-diversion valve is essential in preventing forward flow of sub-temperature product.

APPLICATION—To all flow-diversion valves used with HTST pasteurizers.

FREQUENCY—Upon installation and at least quarterly thereafter.

CRITERIA—The flow-diversion valve shall function correctly in operating situations and shall de-energize the metering pump in the event of malfunction or incorrect assembly.

A. LEAKAGE PAST VALVE SEAT

METHOD—Observe the valve seat of the flow-diversion valve for leakage.

TEST PROCEDURE—With the HTST unit operating with water, reduce the temperature of the heating medium sufficiently to cause the flow-diversion valve to assume the diverted flow position. Disconnect the forward flow piping and observe the valve seat for leakage. If leakage is noted, other suitable repairs must be made.

B. OPERATION OF VALVE STEM

METHOD—Observe flow-diversion valve stem for ease of movement.

TEST PROCEDURE—Tighten stem packing nut as much as possible and check for air leaks from diaphragm motor or bent valve stem, which could cause sluggish operation. Operate HTST unit. Place valve in forward and diverted flow several times using the manual diversion button. Note freedom of action of valve stem. If valve action is sluggish, suitable adjustment or repair shall be made to permit stem to move freely in all positions with packing nut fully tightened.

C. VALVE ASSEMBLY

METHOD—Observe functioning of metering pump when flow-diversion valve is improperly assembled.

TEST PROCEDURE (valves which are pushed to the diverted position)—(a) Operate HTST unit, with either product or water, in diverted flow, with one gasket in place. With an open end wrench used for sanitary fittings unscrew by one-half turn the 13H hex nut which holds the top of the valve to the valve body. If the valve microswitch is in proper adjustment, the resultant over travel of the valve stem should be sufficient to break the microswitch contact, thus de-energizing the metering pump starter and causing the pump to stop. This test method has the disadvantage of sometimes spurting hot liquid from the loosened hex nut at the top of the flow-diversion valve. This hazard can be avoided by an alternate procedure as follows: Under the same test conditions, stop the metering pump with the manual control button before unscrewing the hex nut by one-half turn; then attempt to restart the metering pump manually. If it does not restart, the microswitch adjustment on the flow-diversion valve is satisfactory; if the metering pump restarts, shut it off immediately to r e possible spillage at the flow-diversion valve.

If the me ng pump fails to respond to either of these two alternate procedures, as indicated, an immediate check of the

valve assembly and/or wiring is required to locate and correct the cause. In this case, first proceed further as follows:

(b) With the HTST unit in operation and the flow-diversion valve in the diverted position, remove the connecting key located at the base of the valve stem. The metering pump should be de-energized.

Failure to meet either of the two alternate procedures of test (a) could mean that the microswitch on the flow-diversion valve is slightly out of adjustment, whereas failure to meet test (b) could mean that a short-circuit has developed in the microswitch control wiring, or that it is improperly wired. In either case, immediate correction is called for.

D. MANUAL DIVERSION WHEN BOOSTER PUMP IS USED IN HTST UNIT

METHOD—Observe the response of the booster pump control of the HTST system to manual diversion of the flow-diversion valve.

TEST PROCEDURE—With the HTST unit in operation and the flow-diversion valve in the forward flow position, press the manual diversion button. This should (a) cause the valve to assume the diverted flow position and (b) de-energize the booster pump; the pressure differential between raw and pasteurized product in the regenerator should be maintained. If (a) and (b) do not occur as described or the necessary pressure differential of at least one pound psi in the regenerator is not maintained, the assembly and wiring of the HTST unit should be immediately reviewed and the indicated deficiencies corrected. The energizing of the starter for a booster pump, whether controlled by a pressure switch or a time-delay switch, as discussed in Test 9 following, should also not be possible unless simultaneously (a) the metering pump is in operation and (b) the flow-diversion valve is in the forward flow position. (See page 79 of the *Grade "A" Pasteurized Milk Ordinance.*) Control for the latter condition should be wired through the microswitch on the flow-diversion valve, which indicates actual valve movement from the diverted position, rather than through the thermal control microswitch in the recorder-controller, which indicates only legal or sublegal temperatures. This offsets any conditions, such as loss of air pressure or inadvertent failure to turn on the valve supplying compressed air to the flow-diversion valve, which might result in unsatisfactory relative pressures in the regenerator after the booster pump is energized.

E. RESPONSE TIME

METHOD—Determine with a stopwatch the elapsed time between the instant of the activation of the control mechanism at cut-out on declining temperature and the instant the flow-diversion valve reaches the fully-diverted flow position. This should not exceed one second.

TEST PROCEDURE—Insert the sensor bulb of the recorder-controller in a water bath slightly above the cut-out temperature, and allow the water bath to cool gradually. At the moment the cut-out mechanism is activated, start the watch, and at the moment the valve reaches full divert position, stop the watch. Record results. Should response time exceed one second, immediate corrective action should be taken. Satisfactory results should be recorded as one second or less than one second ($<$ one second).

TEST NO. 9—SETTING OF CONTROL SWITCHES: REGENERATOR PRESSURES

REASON—When a booster pump is used in a HTST unit, automatic control switches are needed to assure that its operation is so timed with respect to the operation of other components that proper relative pressures will be maintained in the regenerator during the entire operating sequence of the HTST unit. The tests enumerated herein concern proper setting for the various types of these switches, and for determining the accuracy of pressure gauges.

A. PRESSURE SWITCHES—USED TO CONTROL OPERATION OF BOOSTER PUMPS

APPLICATION—To all pressure switches controlling the operation of booster pumps on HTST units employing regenerators.

FREQUENCY—Upon installation, quarterly thereafter, after any change in the booster pump or the switch circuit, and/or whenever the pressure switch seal is broken.

CRITERIA—The pump shall not operate unless there is at least a one pound differential on the pasteurized milk side of the regenerator.

APPARATUS—Sanitary pressure gauge and pneumatic testing device for checking and adjusting pressure switch settings, and electrical connections and test lamps, as indicated. (Fig. 1.)

A simple inexpensive pneumatic testing device may be made from a discarded 2"—7 BX sanitary tee, with two additional 13 H nuts, one of which is provided with a 16A cap, drilled and tapped for a one-half inch galvanized iron nipple for the air connection. A hose connection is made to a compressed air source in the plant by means of a snap-on fitting. The air pressure can be controlled by an inexpensive pressure reducing valve (range 0-60 p.s.i.g.) followed by a ½ inch globe type bleeder valve connected into the side outlet of a ½ inch tee installed between the pressure reducing valve and the testing device. The pressure switch to be tested is disconnected from the pasteurizer and connected to another of the outlets of the sanitary tee, and the pressure gauge is connected to the third outlet of the sanitary tee. By careful manipulation of the air pressure reducing valve and the air bleeder valve, the air pressure in the testing device may be regulated slowly and precisely. (In operating the device, care should be taken to avoid exposing the pressure switch and the sanitary pressure gauge to excessive pressure which might damage them. This can be done by first closing off the air pressure regulating valve and opening fully the bleeder valve; these may then be manipulated slowly to bring the air pressure in the testing device within the desired range.) A test light of proper voltage can be placed in series with the pressure switch contact and in parallel with the electrical load (booster pump starter) so the actuation point may be readily determined. (This testing device is similar to that described in an article "A Simple Pneumatic Tester for Checking and Setting Pressure Switches for HTST Booster Pump Control," Tom W. Proctor, *Journal of Milk and Food Technology*, Vol. 24, No. 10, October 1961.)

METHOD—Check and make adjustment of pressure switch so as to prevent the operation of the booster pump unless the pressure on the pasteurized product side of the regenerator is greater by at least one pound per square inch than any pressure that may be generated on the raw side.

TEST PROCEDURE NO. 1—Diaphragm Microswitch Type of Pressure Switch (Taylor Instrument Co., No. 745174, or similar type).

1. Determine maximum pressure of booster pump.

(a) Install sanitary pressure gauge in tee at discharge of booster pump.

(b) Operate the pasteurizer with water, with the flow-diversion valve in forward flow position, the metering pump operating at minimum speed possible, and the booster pump operating at its rated speed. If vacuum equipment is located between the

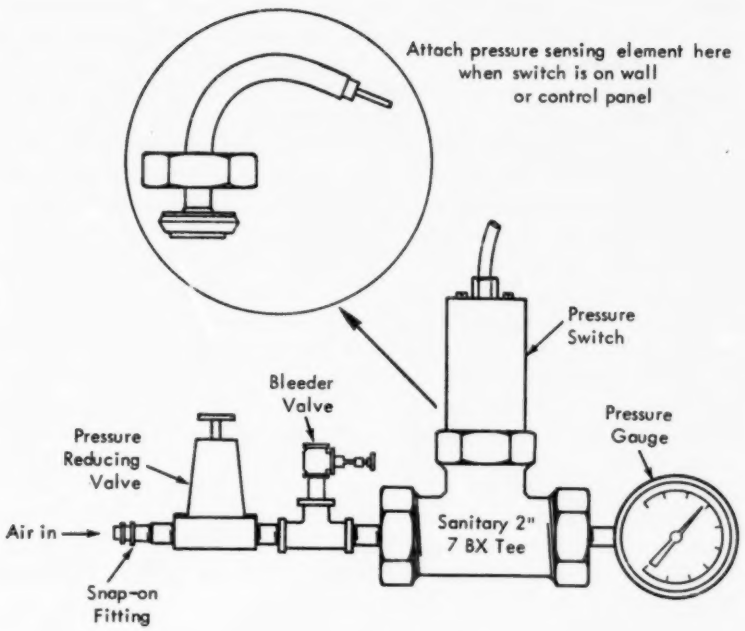

Figure 1. A Simple Pneumatic Tester for Checking Pressure Switches and Gauges

raw outlet from the regenerator and the metering pump, it should be bypassed while this determination is made.

(c) Note maximum pressure indicated by pressure gauge under these conditions.

2. Check and set the pressure switch.

(a) Install a sanitary pressure gauge of known accuracy on the pneumatic testing device to which the pressure switch sensing element should also be connected.

(b) Remove the seal and cover to expose adjustment mechanism on pressure switch.

(c) Operate the testing device and determine the pressure gauge reading at the cut-in point of the pressure switch which will light the test lamp; and second the pressure gauge reading at the cut-out point which will extinguish the test lamp. (If the switch is short-circuited, the lamp will be lighted before air pressure is applied.)

(d) The cut-in point should be higher than the cut-out point and the cut-out point should be at least one pound per square inch greater than the maximum discharge pressure of the booster pump, as determined under item no. 1 preceding. Where adjustment is necessary, refer to manufacturer's instructions for adjusting procedure. After adjustment, recheck actuation point and readjust, if necessary.

(e) Replace cover and seal the pressure switch and restore sensing element to original location.

(f) Record test results for the office record.

TEST PROCEDURE NO. 2—Dial Type Pressure Switch (Taylor Instrument Co., Type X61KN, or similar type).

1. Determine maximum discharge pressure of booster pump.

(a) Install sanitary pressure gauge of known accuracy in tee at discharge of booster pump.

(b) Remove the seal and cover of the dial type pressure switch to expose the dial, pointer and alarm contacts.

(c) Operate the pasteurizer wi.. water, with the flow-diversion valve in forward flow position, the metering pump operating at minimum speed possible, and the booster pump operating at its rated speed. If the booster pump is not running, it may be started by making momentary contact between the high pressure alarm contact and the gauge pointer. Since the gauge pointer is grounded to the instrument case, the booster pump may be started by shorting between the instrument case and high pressure alarm contact. To start the booster pump (1) install a sealing stud in the case; (2) attach one end of a shorting probe to the sealing stud; and (3) momentarily apply the other end of shorting probe to the high pressure alarm contact.

(d) Record maximum pressure indicated by pressure gauge under these conditions. If vacuum equipment is located between the raw outlet from the regenerator and the metering pump, it should be bypassed while this determination is made.

2. Check and set the pressure switch.

(a) Install a sanitary pressure gauge of known accuracy in the pneumatic testing device to which the pressure switch sensing element should also be connected.

(b) Connect one side of a 30 volt test lamp to sealing stud in instrument case of dial type pressure switch. Connect other side of test lamp to bus strip from low pressure alarm contact. When the dial type pressure switch and transformer are connected to the wiring of the pasteurizer as recommended in Taylor Instrument Company's Bulletin No. 7F101—Issue 1, the test lamp will be on whenever the booster pump is running and the lamp will be off whenever the booster pump is off.

(c) Turn on power to pasteurizer controls.

(d) By operating the testing device determine first the pressure gauge reading at the cut-in point which will light the test lamp and second, the pressure gauge reading at the cut-out point which will extinguish the test lamp. The cut-in point should be higher than the cut-out point, and the cut-out should be at least one pound per square inch greater than the maximum discharge pressure of the booster pump as determined under item no. 1 preceding.

(e) If adjustment is necessary, move the low pressure alarm contact to zero scale position and move the high pressure alarm contact to full scale position. By operating the pneumatic testing device, apply a pressure at least one pound per square inch greater than that determined under item no. 1 preceding. If test lamp is not on, make a momentary contact between instrument case and high pressure alarm contact. Slowly move the low pressure alarm contact upscale until the test lamp is turned off. Slowly move the high pressure alarm contact downscale until it is as close as possible to the low pressure alarm contact. Recheck activation points as in the preceding step and readjust, if necessary.

(f) Replace cover and reseal pressure switch and restore pressure switch sensing element to original location.

(g) Record test results for the office record.

B. TIME DELAY SWITCHES—USED TO CONTROL OPERATION OF BOOSTER PUMPS

APPLICATION—To all time delay switches controlling operation of booster pumps on HTST units employing regenerators.

FREQUENCY—Upon installation, after any change in the pump or relay circuit, and whenever seal is broken.

CRITERIA—The booster pump shall not operate until the pasteurized product has achieved a pressure at least one pound greater than the maximum pressure developed by the booster pump.

TEST PROCEDURE—(Reference: "Use of Time Delay Relay to Control Booster Pump Operation," Dashiell, W. N., *Journal of Milk and Food Technology*, 21:7, July 1958.)

(a) Operate pasteurizer with water with the flow-diversion valve in forward flow position, metering pump operating at minimum speed, booster pump at rated speed. Vacuum equipment not operating or bypassed.

(b) Determine the maximum pressure developed at the discharge of the booster pump by means of a pressure gauge of known accuracy. The reading in pounds per square inch should then be multiplied by 2.3 to convert to an equivalent height of water column. For example, a reading of five pounds per square inch multiplied by 2.3 gives a water column equivalent of 11.5 feet. The vertical height of the equivalent water column may also be determined directly by connecting an open end piping or hose arrangement to the booster pump discharge, while HTST unit is in operation with water, and elevating the open end to the point where the flow is reduced to zero, and the operation of the booster pump is merely supporting the column of water. Following determination of the height of the water column add at least three feet to provide the one pound differential and to compensate for difference in the specific gravity between water at 161°F and raw product at 40°F. The pasteurized liquid level must rise to the computed elevation, above the outlet level of the booster pump, and be continuously vented to the atmosphere at this or higher level.

(c) Time with a stopwatch the interval from the moment forward flow is established until the pasteurized liquid level rises to the required elevation. A temporary open pipe connection at the required elevation will facilitate this observation. The time measurement must be made at the beginning of a run when no liquid is in the pasteurized product flow path downstream from the flow-diversion valve. The booster pump shall not be operating.

(d) The time delay relay shall be installed in the circuit, interlocked with the metering pump, forward flow of the flow-diversion valve and the booster pump starter. Adjust the time delay setting to provide the proper time interval. Recheck the time after setting, adjusting if necessary. Seal the time delay relay. If delay relay does not function properly, secure another one.

(e) Record setting for permanent office record.

C. PRESSURE GAUGES—USED WITH BOOSTER PUMP OPERATIONS

APPLICATION—To all required pressure gauges used to indicate raw product and pasteurized product pressures in HTST regenerators.

FREQUENCY—Upon installation, quarterly thereafter, and whenever the gauges are adjusted or repaired.

CRITERIA—Required pressure gauges shall be accurate.

TEST PROCEDURE—A pressure gauge of known accuracy is connected to one outlet of the pneumatic testing device previously described under Test No. 9(A). The gauge to be checked is connected to another outlet. Operate the device and check the gauge accuracy through the normal operating range of that particular HTST unit. If necessary, adjust the pointer setting of the gauge being tested to read properly at atmospheric pressure. No other adjustment should be attempted by the plant operator. If the gauge will not, thereafter, indicate properly throughout its operating range, it should be returned to the manufacturer for repair. Record test results for official records.

TEST NO. 11—CONTINUOUS FLOW HOLDERS—HOLDING TIME

REASON—Accurate determination and control of the minimum flow through or holding time, under the fastest possible condition of flow, is essential for effective control of the pasteurization process.

APPLICATION—To all HTST pasteurizers with continuous flow holding tubes.

FREQUENCY—Upon installation and semiannually thereafter, whenever seal on pump speed setting is broken; any alteration is made affecting the holding time, the velocity of flow (such as replacement of pump, motor, belt, drive or driven pulleys or decrease in number of HTST plates) or the capacity of holding tube; or whenever a check of the capacity indicates a speedup.

CRITERIA—Every particle of product shall be held continuously for at least 15 seconds in both the forward and diverted flow positions.

TEST PROCEDURE—The holding time is determined by timing with a stopwatch or automatic timer the interval for particles of sodium chloride to pass through the holding tube, as evidenced by observation of increased electrical conductivity as an

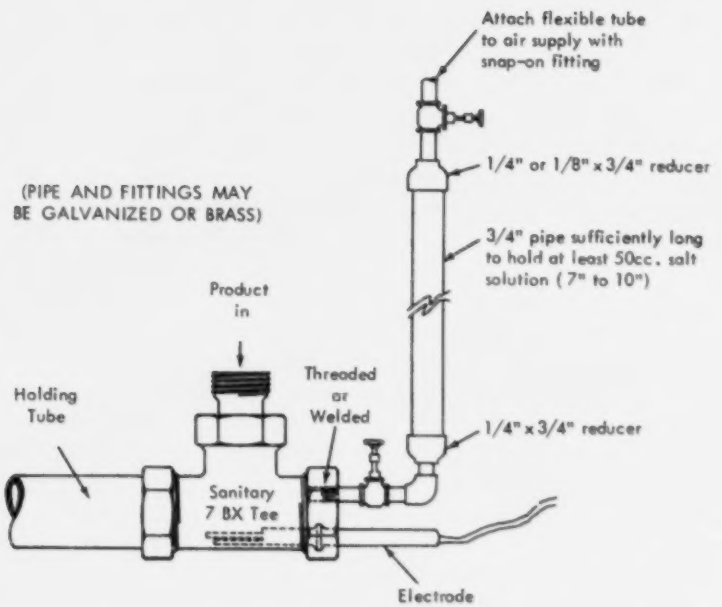
Attach flexible tube to air supply with snap-on fitting
1/4" or 1/8" x 3/4" reducer
(PIPE AND FITTINGS MAY BE GALVANIZED OR BRASS)
3/4" pipe sufficiently long to hold at least 50cc. salt solution (7" to 10")
Product in
Threaded or Welded
Holding Tube
1/4" x 3/4" reducer
Sanitary 7 BX Tee
Electrode

Figure 2. Suggested Method for Injecting Salt Solution Using Plant Compressed Air

injected salt solution passes electrodes placed at the inlet and outlet of the holding tube. Although the time interval for the fastest particle of product is desired, the conductivity test is made with water. The results found with water are converted to the product flow time by formulation, since the metering pump may not deliver the same amount of product as it does of water. Proceed as follows:

1 Examine and modify the entire system as necessary to insure that all flow promoting equipment is operating at maximum capacity and all flow impeding equipment is so adjusted or bypassed as to provide minimum frictional resistance to flow. This means, that (a) clarifiers and separators should not be operating, (b)

in-line filters must be removed, (c) homogenizers should be operating without pressure on the valves, (d) booster pumps should be in operation and (e) vacuum equipment in the system should be operating at maximum vacuum. (This can be done by increasing the weight on the poppet-type air relief for straight-vacuum equipment, and by removing from the line and exposing to room temperature the outlet ratio-controller bulb of steam-vacuum equipment.) Also, before the tests are begun the HTST system should be operated with water in forward flow for a sufficient time to purge the air from the system, and pipe connections on the suction side of the metering pump should be made tight enough to exclude entrance of air.

2 Adjust the variable-speed metering pump to its maximum controlled capacity by turning the control wheel until it is fully stopped by the sealed stop-setting mechanism. If adjustments are later found to be necessary in the stop-setting, it is important to make sure that the control wheel is properly positioned against the stop each time that a timing test is made. Timing tests should preferably be made with a new belt on the metering pump. Homogenizers should be checked for gear or pulley identification, and if of the two-speed type, the timing tests for milk and milk products should be performed at the higher speed of the homogenizers.

3 Install one timing electrode at the inlet to the holder and the other electrode in the holder outlet. The latter may be installed in the sanitary fitting at the downstream end of the holder, or it may be inserted in the indicating thermometer fitting. Make necessary electrical connections to an electrical conductivity measuring device.

4 Operate the pasteurizer with water with flow-diversion valve in forward flow position.

5 Prepare a saturated solution of salt. Usually a quart or more should be prepared. Fill a syringe with 50 ml or more of the salt solution, and quickly inject into the holder inlet, watching the conductivity instrument closely.

6 Start the stopwatch with the first movement of the conductivity indicator. Open the circuit of the inlet electrode and close the circuit to the electrode at the outlet of the holder. (If an automatic timer is used, it will start and stop automatically, but the circuits have to be changed manually.)

7 Stop the stopwatch with the first movement of the indicator of a change in electrical conductivity.

8 The stopwatch reading, or the reading of the timing device, is the holding time (for water) which should be recorded.

9 Repeat the test six or more times until six successive tests are within 0.5 seconds. The average of these six tests is the holding time for water in forward flow. If consistent readings cannot be obtained, purge the equipment of air, check instruments and connections, and check for loose connections on suction side of metering pump. Repeat tests. Should consistent readings not be obtained, use the fastest time as the holding time for water.

10 Repeat steps (4) through (9) for testing time on water in diverted flow. This is necessary because if the holding time in diverted flow is shorter, because of a lesser operating pressure due to decreased friction when in diversion, any particles of product, which reach the end of the holding tube at the moment the flow-diversion valve moves into forward flow position, will have been held only for the shorter holding period corresponding to diversion. Therefore, the holding time in both forward and diverted flow must not be less than 15 seconds.

11 With the metering pump operating at the same speed and equipment adjusted as in (1) above, time with a stopwatch the filling of a ten-gallon can with a measured weight of water, using the discharge outlet with the same head pressure as in normal operation. This can be done conveniently by placing the can on a platform scale and adjusting the scale weights to correspond to the weight of a can full of water. Average the time of several trials. (Since flow rates of the larger capacity HTST units make it difficult to check by filling a ten-gallon can, it is suggested that a tank of larger size be used.)

12 Repeat procedure (11), using milk.

13 Compute the holding time for milk from the following formula by weight, using the average specific gravity of milk. Compute separately for the forward flow and diverted flow holding times for water, as previously determined.

$$\text{Holding time for milk} = \frac{1.032\ (TMw)}{Ww}\ \text{(by weight)}, \text{ in which}$$

1.032 = average specific gravity for milk
T = average holding time for water
Mw = average time required to deliver a measured weight of milk
Ww = average time required to deliver an equal weight of water

14 After a satisfactory holding time is established, seal

the stop setting on the pump and record results for office records. When a homogenizer is used as the timing pump, its motor speed, shaft and pulley (or gear) sizes and other pertinent data should be recorded for office records and the drive housing access ports should be sealed; if no sealing arrangement is practicable, the shaft and pulleys or gears should be appropriately marked for future identification checks.

When the computed holding time for milk is less than that required in either forward or diverted flow, the speed of the metering pump shall be reduced or adjustment made in the holding tube, or diverted flow line, and the timing test repeated until a satisfactory holding time is achieved. Should an orifice be used to correct the holding time in diverted flow, there should be no excessive pressure exerted on the underside of the forward flow valve seat of the flow-diversion valve.

Part III—ADDITIONAL TESTS WHEN FLAVOR CONTROL EQUIPMENT IS USED IN CONJUNCTION WITH HIGH-TEMPERATURE SHORT-TIME PASTEURIZATION

Flavor control equipment, which includes vacuum and steam-vacuum accessory treatment systems, may, in conformity with the provisions of the *Grade "A" Pasteurized Milk Ordinance*, be installed and operated in conjunction with HTST pasteurization units provided such equipment has safeguards so that it will (1) not interfere with the detection of, or stoppage of, the forward flow of underpasteurized product past the forward flow seat of the flow-diversion valve; (2) not influence adversely the proper pressure relationship in the regenerator; (3) not reduce the holding time below the required minimum (as discussed under Test 11, Part II); (4) not contaminate the product with toxic substances or foreign material through the use of substandard steam or steam application systems; and (5) not adulterate the product with added water.

Flavor control equipment may consist of (1) a single chamber vacuum system, with no direct addition of steam, installed upstream from the heating section of the HTST unit; (2) a single chamber vacuum system, with no direct addition of steam, installed downstream from the flow-diversion valve; (3) a single or double chamber vacuum system with direct steam addition, downstream from the flow-diversion valve; (4) a double chamber vacuum system, one upstream from the heating section and the other downstream from the flow-diversion valve. Other combinations or modifications of flavor control equipment are also acceptable, provided they have safeguards against possible sanitary defects as outlined in the preceding paragraph.

Inspection of the flavor control and appurtenant equipment hookup in a given HTST installation, together with a check of the boiler compounds in use, will indicate whether the safeguards called for in the *Grade "A" Pasteurized Milk Ordinance* have been provided. A few simple tests, as follows, are necessary; however, to assure that these are working properly and effec-

tively. These tests are not included in the numbered tests shown in Figure 3, Milk Plant Equipment Tests Report, nor is a minimum frequency of performance specified in the *Milk Ordinance*. It is suggested, however, that all of the tests be performed upon installation, and at least quarterly thereafter.

TEST A—PREVENTION OF SUBATMOSPHERIC PRESSURE AT FLOW-DIVERSION VALVE

REASON—When vacuum equipment is located downstream from the flow-diversion valve, means shall be provided to eliminate negative pressure between the forward flow port of the flow-diversion valve and the inlet to the vacuum chamber during diverted flow or metering pump shutdowns. Unless prevented, this negative pressure from continued operation of the vacuum unit could cause forward flow of subtemperature product past the flow-diversion valve on cut-out, if for any reason the valve failed to assume the fully diverted position (although this would stop the metering pump if the valve microswitch and starter circuit were working properly). Also even with the forward flow port closed in diversion, a negative pressure immediately downstream from the valve face might permit forward flow by aspiration of particles of underpasteurized product. Item 16pB5(a), page 77, of the *Milk Ordinance*, therefore, requires that an effective vacuum breaker and automatic check valve or positive type shut-off valve (installed downstream from the vacuum breaker) shall be installed between the flow-diversion valve and the inlet to the vacuum chamber directly downstream from the flow-diversion valve.

APPLICATION—To all vacuum and steam-vacuum equipment located downstream from the flow-diversion valve.

CRITERIA—No vacuum at the forward flow seat of the flow-diversion valve at any time.

TEST PROCEDURE—The effectiveness of the installation is evaluated by disconnecting the forward flow piping at the flow-diversion valve, while the valve is in diverted flow position and the vacuum equipment is operating, and checking the pipe for negative pressure. This is easily determined by placing the hand or a sheet of paper over the open end of the pipe. Unless satisfactory, the installation should be modified or replaced, so as to function effectively. Record test results for office record.

TEST B—MAINTENANCE OF PROPER RELATIVE REGENERATOR PRESSURES (SUPPLEMENTARY TO TEST 9, PART II)

REASON—When vacuum equipment is located downstream from the flow-diversion valve, means shall be provided to prevent lowering of the pasteurized milk pressure in the regenerator during periods of diverted flow or shutdown. Unless prevented, the negative pressure from continued operation of the vacuum unit could aspirate product from the pasteurized side of the regenerator (in a reversal of normal flow condition) and reduce the pressure there to below that on the raw side. Item 16pC8, page 79, of the *Milk Ordinance*, therefore, requires that an automatic check valve or positive type shut-off valve and an effective vacuum breaker (installed downstream from the valve) shall be installed in the line between the vacuum chamber and the pasteurized product inlet to the regenerator. (If there is an intervening homogenizer, the vacuum breaker should be installed at the high point in the line downstream from the homogenizer.)

APPLICATION—To all vacuum and steam-vacuum equipment located downstream from the flow-diversion valve and upstream from a regenerator.

CRITERIA—No vacuum at the pasteurized product inlet to the regenerator at any time.

TEST PROCEDURE—The effectiveness of the installation is evaluated by disconnecting the pasteurized product inlet line at the regenerator, while the flow-diversion valve is in diverted flow position and the vacuum equipment is operating and checking the pipe for negative pressure. This is easily detected by placing the hand or a sheet of paper over the open end of the pipe. Unless satisfactory, the installation should be modified or replaced, so as to function effectively. Record test results for office records.

TEST C—PREVENTION OF ADULTERATION WITH WATER-STEAM CONTROL VALVE

REASON—When culinary steam is introduced directly into the product downstream from the flow-diversion valve, automatic means should be provided to prevent addition of steam to the product unless the flow-diversion valve is in the forward flow position; otherwise, upon resumption of forward flow after an extended diversion period a considerable quantity of water from condensed steam would be co-mingled with the initial flow of pasteurized product. Item 16p(B)6a, page 78, of the *Milk Ordinance*, therefore, requires an automatic steam control valve which

will stop the flow of steam, either through a thermal control with a temperature sensor located downstream from the steam inlet, or through an electrical solenoid actuated by the flow-diversion valve, when the latter is in diverted flow position.

APPLICATION—To all steam-vacuum equipment located downstream from the flow-diversion valve.

CRITERIA—Steam flow to stop automatically when flow-diversion valve assumes diverted flow position.

TEST PROCEDURE—The effectiveness of the installation is evaluated by causing the flow-diversion valve to divert while the steam-vacuum unit is operating and observing if the steam valve automatically shuts off the steam flow, as determined from the positioning of the valve. Unless satisfactory, the installation should be modified or replaced. Record test results for office record.

TEST D—PREVENTION OF ADULTERATION WITH WATER—WATER CONTROL VALVE TO DIRECT WATER-VAPOR VACUUM CONDENSER

REASON—In the direct type of water-vapor vacuum condenser the vapors from the vacuum equipment are cooled and condensed by a continuous inflow of water which mingles directly with vapors, the resultant liquid then being discharged to waste through a condensate pump. (This is in contrast with the indirect type of condenser, in which the cooling water is physically separated from the vapor (and vacuum) by a metal plate, as in a plate-type heat exchanger. Unless safeguarded against, there is a danger of back-up and overflow of cooling water and condensate from a direct type of water-vapor vacuum condenser into the product vacuum chamber, in the event of condensate pump failure, tailpipe failure, or power failure. Item 16p(B)6c, page 78, of the *Milk Ordinance*, therefore, requires the use of an automatic safety shut-off valve installed on the water supply, actuated by a sensing device located in the vacuum condenser above the normal operating water level, which will shut off the inflowing water when the water level in the condenser reaches the level of the sensing device. The safety shut off valve may be actuated by water pressure, by compressed air, or electrically, but is required to be so designed that failure of the primary motivating power will automatically stop the flow of water into the vacuum condenser. In other words, the valve should shut off if the air or water pressure or the operating current fails.

APPLICATION—To all direct type water-vapor vacuum condensers used in flavor control equipment.

CRITERIA—Water safety shut-off valve designed to close automatically on failure of primary motivating power, and so controlled to shut off inflow when water level in condenser rises to level of control sensing device. No backflow of water into product vacuum chamber.

TEST PROCEDURE—First, determine that the design of the automatic water shut-off valve is such that cutting off the primary motivating power (electric, or pneumatic or water pressure) will cause the valve to close. Then, turn on vacuum pump for flavor control equipment and operate the unit under vacuum, but empty, and with no product or water flowing through and with product-discharger pump shut off. Turn on manual control valve for water flow to vacuum condenser, but with condensate removal pump not operating. Observe, as the water level rises in the condenser that the water safety shut-off valve closes before water rises and backflows into product vacuum-chamber. After valve shut off, open product vacuum-chamber and check for possible backflow of water. If unsatisfactory, make repairs or changes as needed, until shut-off valve functions properly. Record results for office records.

TEST E—PREVENTION OF ADULTERATION WITH WATER—AUTOMATIC CONTROLLER FOR VACUUM

REASON—When steam is introduced directly into the product, as in steam-vacuum flavor control equipment, there is need for automatic means of controlling the vacuum, to maintain a proper temperature differential between incoming and outgoing product, and thus avoiding either concentration or dilution and assuring original product composition. Otherwise, the product could possibly be adulterated with added water from the condensed steam; alternately, concentration of product would not violate the requirements of the *Milk Ordinance*, but would be uneconomic for the operator. Item 16p(B)6b, page 78, of the *Milk Ordinance*, therefore, requires that when steam is introduced directly into the product automatic means shall be provided for maintaining the temperature differential necessary to preclude dilution with water. Such means should include an automatic ratio controller which (a) senses the temperature of the product just prior to the addition of steam and again at the outlet of the vacuum chamber and (b) automatically adjusts the operating vacuum in the vacuum chamber so as to assure the removal, by evaporative cooling, of all water added in the form of steam. The outlet temperature, thus, has to be controlled at a fixed lower level than the inlet temperature, to compensate for the radiant heat loss from the

unit, which would, otherwise, leave added water in the product. (The larger the radiant heat loss, the greater the temperature differential that has to be maintained to avoid dilution of product.) The correct temperature differential has to be determined for each individual installation. Greater differentials call for a greater amount of vacuum, and the range of required differential settings is usually from about 2°F to 8°F below the temperature of the incoming product.

APPLICATION—To all automatic vacuum controllers used with steam-vacuum flavor control equipment.

CRITERIA—Proper controller setting to prevent dilution of product.

TEST PROCEDURE—Initially, operate the steam-vacuum unit with product, with the vacuum controller at the temperature differential setting recommended by the manufacturer. From sampling points immediately upstream and downstream from unit, collect a series of product samples for total solids determination by Majonnier or substantially equivalent method. Adjust controller differential setting as necessary, to bring the results into close enough agreement so that no dilution results. On quarterly tests, thereafter, repeat the test procedure and change previous setting, if necessary, to obtain desired results. Seal the differential setting and record results for office records.

Part IV—GUIDELINES FOR INSPECTION OF BATCH PASTEURIZATION EQUIPMENT

Inspection of batch pasteurization equipment covers elements of design, construction, installation, operation and maintenance. These guidelines attempt to summarize briefly the essential requirements of the *Grade "A" Pasteurized Milk Ordinance* for batch pasteurizers and appurtenant equipment, with the exception of those relating to cleaning and bactericidal treatment (Item 12p, page 65 of the *Milk Ordinance*). They complement but do not replace the specific equipment tests for batch pasteurizers as detailed in Part I of this manual. Item and page references to the *Milk Ordinance* are cited for each heading, for additional details as the need may arise.

A. CONSTRUCTION AND REPAIR OF EQUIPMENT (ITEM 10p AND 11p, PAGE 62)

The general requirements of Items 10p and 11p on construction and repair of equipment and sanitary piping apply to batch pasteurizers. Observe:

1 That product-contact surfaces of the pasteurizer and appurtenant equipment including the underside of the cover are of smooth, impervious, corrosion resistant, and nontoxic material, free from breaks, crevices, and corrosion, and with joints flush and finished as smooth as adjoining surfaces.

2 That corners are rounded to facilitate cleaning.

3 That all openings in pasteurizer covers are protected by raised edges or otherwise to prevent the entrance of surface drainage.

4 That condensation diverting aprons or watertight joints are provided for inlet pipes and thermometers extending into the pasteurizer, and that all other openings into the pasteurizers are provided with covers; agitator shafts extending through the cover are provided with diverting aprons.

5 That where a thermometer extends through a sidewall with which product comes in contact, a pressure-tight seal is provided ahead of all threads and crevices.

6 That all product-contact surfaces are readily accessible for inspection and are self-draining, and that they are easily accessible for manual cleaning or designed for mechanical cleaning.

7 That there are no threads used in product-contact areas.

8 That inlet and outlet valves and intervening piping conform to the foregoing criteria on construction and repair.

B. ADEQUATE AGITATION (ITEM 16p(A)1a, PAGE 70)

Observe that each batch pasteurizer is equipped with an agitator, which is operated continuously throughout the holding period, and that no batch of product is pasteurized unless it covers a sufficient area of the agitator to insure adequate agitation. The adequacy of agitation should be such that the simultaneous temperature difference between particles of product at the center of the pasteurizer and the coldest particles (which are those at the bottom immediately adjacent to the inner face of the outlet valve) will not exceed 1°F at any time during the holding period. Such differential determinations are usually made with thermocouple temperature measuring equipment, and there is no practical test for general field use. However, all batch pasteurizers of recent manufacture have been designed to provide adequate agitation. If in doubt, consult the State Milk Control Authority, giving details on the name, capacity, style and serial number of pasteurizer.

C. HOLDING TIME

Observe that each batch pasteurizer is operated so that every particle of product is held at not less than the minimum pasteurization temperature continuously for at least 30 minutes, and that no product is added after the start of the holding period. Where the product is heated to the required temperature in the pasteurizer and cooling is begun in the pasteurizer immediately after the 30 minute holding period (by cutting off the steam and filling or spraying the jacket with tap or cool water), and before opening the outlet valve, the recorder chart will show 30 minutes at or above the required pasteurization temperature, which is satisfactory. However, under certain other operating conditions the product may not have been properly pasteurized even though

the recorder chart shows holding at the required temperature for 30 minutes.

One such condition would occur if the product is heated to the pasteurization temperature before it enters the batch pasteurizer. Since the recorder chart will register the product temperature as soon as the inflowing product reaches the level of the recording thermometer bulb, it is obvious that not all of the product in the pasteurizer will have been held for the full 30 minute period if the holding time shown by the chart is only 30 minutes. Under this condition the chart should show at least 30 minutes plus the average filling time from the level of the bottom of the recording thermometer bulb to the level one inch below the bottom of the air space thermometer bulb. This average filling time should be determined from several readings, and the charts should show a holding period of 30 minutes, plus the average time.

Another such condition may arise with respect to cooling. If the product is cooled entirely outside the pasteurizer, the chart will still show the pasteurizing temperature after emptying begins, until the product level drops below the level of the recording thermometer bulb. Under this condition, the chart should show at least 30 minutes plus the average emptying time from a level one inch below the bottom of the air space thermometer bulb to the level of the bottom of the recording thermometer bulb. This emptying time may vary considerably depending upon the amount of product in the pasteurizer and the size of containers being filled. Consequently, the emptying time should be checked with different quantities of product in the pasteurizer, and at different container filling rates, so that recorder charts may be interpreted properly. The charts should show a holding period of 30 minutes plus the average emptying time for the operating condition. However, as previously indicated, if cooling is begun in the pasteurizer before the outlet valve is opened, the chart need show a holding time (at pasteurization temperature) of only 30 minutes, unless the filling time is required to be shown (see preceding paragraph). The practice of beginning cooling in the pasteurizer after the outlet valve is opened should not be permitted, as examination of the recorder charts of such operations will not reveal whether the product was held at pasteurization temperature for at least 30 minutes.

Attention is called to the fact that in some installations the recorder charts should show a holding time of 30 minutes plus both the filling and the emptying times, depending on operating conditions as previously discussed.

D. AIR SPACE HEATING (ITEM 16p(A)2, PAGE 71; APP. H III, PAGE 146; AND ITEM 15p, PAGE 68)

Observe that each batch pasteurizer is equipped with an air space heater assembly containing all components as illustrated in the *Milk Ordinance* (page 148), and that the unit is properly operated during pasteurization so that the air space above the product in the pasteurizer is maintained at a temperature not less than 5°F higher than the minimum required temperature of pasteurization during the holding period, as indicated by the air space thermometer. During non-operating inspections, check to make sure that the steam control needle valve is operable, and that the ⅛" drain hole in the cap at the bottom of the auxiliary water trap has not become plugged through mineral deposition.

Observe that boiler compounds used for generating steam for the air space heater are non-toxic (App. H, page 147) so as to provide steam of culinary quality.

E. THERMOMETERS—INDICATING, RECORDING, AND AIR SPACE (ITEM 16pA, PAGE 69, AND APP. H IV, PAGE 148)

Observe that each batch pasteurizer is equipped, during operation, with an indicating, recording, and air space thermometer complying with the applicable specifications of appendix H, page 148, of the *Milk Ordinance*. Thermometers may be transferred from one batch pasteurizer to another, but they must be in position during the entire filling, heating, holding and emptying periods of the pasteurization process. Check the identification of the thermometers against those previously tested, as outlined in Part I, and arrange for testing of new thermometers.

Observe that the bottom of the bulb of the air space thermometer is at least one inch above the product level in the batch pasteurizer. Observe also that no batch of products is pasteurized unless there is sufficient quantity to cover the bulbs of both the indicating and the recording thermometers.

Observe that all thermometers are operating properly, and check the reading of the recording thermometer against the indicating thermometer; if necessary, have the operator adjust the former to read no higher than the indicating thermometer. Record indicator thermometer reading on recorder chart with reference mark at appropriate point on temperature curve, and initial. Observe air space thermometer reading; record reading on recorder chart, and initial.

Examine recorder charts as completed by operator since

last preceding official inspection. See that the holding pin perforations at the center of the charts have not been expanded. The charts should be completed with (a) date, (b) number of recorder when more than one is used, (c) extent of holding period at or above pasteurization temperature, including, when necessary, filling and/or emptying times as previously determined, (d) readings of indicating thermometer and air space thermometer within the holding period, with appropriate reference marks on the recorded temperature arc, (e) name and amount of product for each batch pasteurized, (f) record of unusual occurrences, if any, and (g) initials of operator and name of plant. Discuss any inconsistencies with operator, and record deficiencies on inspection form. The charts should be preserved for three months. Use by the operator of a rubber stamp format (see illustration below) for these entries usually facilitates satisfactory completion of the information called for on the charts.

Date_____ Plant Name_____
Number of Recorder_____
Ind. Thermometer Read_____ at_____
Airspace Thermometer Read_____ at_____
Product_____, Gals._____
Signature or Initials of Operator_____
Unusual Occurrences_____

F. INLET AND OUTLET VALVES AND CONNECTIONS (ITEM 16pA3, PAGE 71)

1 Inlet valves—Observe that the inlet line to the pasteurizer is provided with a leak-protector valve, which has been tested for effectiveness as outlined in Part I, mounted on a horizontal line or otherwise, so that the leak groove system is at the lowest level of the valve, and that the inlet line between the valve and the pasteurizer is as short as practicable and sloped to drain (an inlet valve is not required if the inlet line is disconnected and the inlet opening covered or capped before pasteurization begins). These requirements are made so that raw product may not enter the pasteurizer during the holding period, and thus be underheld. The construction of the inlet valve should, when in the fully-closed position, provide continuous or mating grooves at least 3/16-inch wide and 3/32-inch deep on each side of the valve and extending throughout the entire depth of the valve seat, without obstructions, so as to provide adequate ventilation for drainage. The inlet valve should be provided with a stop at the fully closed position for the guidance of the operator. In cases where the inlet line extends

down into the pasteurizer so that its lower end may be submerged, it is necessary to provide air relief for drainage of the line when the inlet valve is closed. This may be accomplished by (a) having an automatic air relief on the inlet valve, so designed as to function in every closed position of the valve, or (b) by drilling an $\frac{1}{8}$-inch hole in the inlet line below the vat cover, but above the maximum product level. The inlet valve should be kept fully closed during holding and emptying periods.

2 Outlet valves—Observe that the outlet valve is of the leak protector type, with a stop, as discussed under "Inlet valves," which has been tested for effectiveness as outlined in Part I. There are also additional requirements for outlet valves, as follows:

a They shall be so designed as to prevent the accumulation of unpasteurized product in the plug channel, when the valve is in any closed position. This means that any leakage past the valve seat which reaches the plug channel must be free to drain through the leak protector grooves at any point in the valve traverse from the "just closed" to the "fully closed" position. Otherwise, raw or imperfectly pasteurized product would become trapped in the valve channel when the valve is closed, later to be discharged into the outlet pipe line with the pasteurized product, thus contaminating the latter. Free drainage from the plug channel can be determined by shutting off a flow of water through the valve, collecting and measuring by volume the free drainage of water through the leak grooves, and comparing this volume with the capacity of the plug channel. The latter can be determined approximately by removing the plug, covering one end of the channel with water proof material such as plastic film, filling the channel with water, and then measuring its volume. The two quantities of water should approximate each other.

b They shall be "close-coupled" to the inner wall of the pasteurizer, so that no product particles in the valve inlet are more than 1°F colder than the particles at the center of the pasteurizer during the holding period. This requirement could be determined directly by thermocouple temperature measurements, but may be assumed to be met when (a) the vat outlet is so flared that the smallest diameter of the large end of the flare is not less than the diameter of the outlet line, plus the depth of the flare, and (b) the greatest distance from the small end of the flare to the valve seal is not greater than the diameter of the outlet line, and (c) the outlet and the agitator in the pasteurizer are so positioned as to insure that product currents will be swept into the outlet.

The outlet valve should be kept fully closed during filling, heating, and holding periods.

Part V—GUIDELINES FOR INSPECTION OF HIGH-TEMPERATURE SHORT-TIME PASTEURIZATION EQUIPMENT

Inspection of high-temperature short-time pasteurization equipment, and flavor control and other equipment used in conjunction therewith, covers elements of design, construction, installation, operation, and maintenance. These guidelines attempt to summarize briefly the essential requirements of the *Grade "A" Pasteurized Milk Ordinance* for high-temperature short-time pasteurization equipment, including adjunct flavor control equipment, with the exception of those relating to cleaning and bactericidal treatment (Item 12p, page 65). They complement but do not replace the specific equipment tests for high-temperature short-time pasteurizers as detailed in Part II, and for flavor control equipment in Part III of this manual. Additional information may be found in the cited references to the *Milk Ordinance.*

A. CONSTRUCTION AND REPAIR OF EQUIPMENT— SANITARY PIPING (ITEMS 10p AND 11p, PAGE 62)

The general requirements of items 10p and 11p on construction and repair of equipment and sanitary piping apply to high-temperature short-time pasteurizers and to auxiliary equipment synchronized into basic HTST units. Observe:

1 That all product-contact surfaces of equipment, sanitary piping, fittings, and connections consist of smooth, impervious, corrosion-resistant, nontoxic, easily cleanable material.

2 That all sanitary piping, connections and fittings, and product-contact surfaces of equipment consist of (a) stainless steel of the AISI (American Iron and Steel Institute) 300 series, or (b) equally corrosion-resistant metal which is nontoxic and nonabsorbent, or (c) heat resistant glass, or (d) plastic, or rubber or rubberlike materials which are relatively inert, resistant to scratching, scoring, decomposition, crazing, chipping, and distortion under normal use conditions; which are nontoxic, fat resistant, relatively nonabsorbent; which do not impart flavor or odor to

the products; and which maintain their original properties under repeated use conditions.

3 That sanitary piping, fittings, and connections and equipment are designed to permit easy cleaning, kept in good repair, and free of breaks and corrosion. All interior surfaces of demountable piping, including valves, fittings, and connections are designed, constructed and installed to permit inspection and drainage.

4 That all cleaned-in-place product pipelines of the HTST installation and auxiliary equipment comply with the applicable cleaned-in-place construction requirements of Item 10p of the *Milk Ordinance*.

5 That all joints in equipment are flush and finished as smooth as adjoining surfaces. Where thermometers and temperature sensing elements are inserted through a product-contact surface, a pressure tight seal shall be provided ahead of all threads and crevices.

6 That all surfaces with which products come into contact are easily demountable for manual cleaning or are designed for mechanical cleaning. All product-contact surfaces shall be readily accessible for inspection and shall be self-draining.

7 That no threads are used in contact with products except where needed for functional and safety reasons, as in clarifiers, pumps, and separators, and these must be of a sanitary type. All product-contact corners should be rounded to facilitate cleaning.

8 That all openings in covers of tanks, separators, etc. are protected by raised edges or otherwise to prevent the entrance of surface drainage. That condensation diverting aprons or watertight joints be provided for pipes extending into tanks, and that all other openings be provided with covers.

B. BASIC HIGH-TEMPERATURE SHORT-TIME PASTEURIZERS (ITEM 16p(B)(C)(D), PAGE 74)

HTST pasteurization of milk and milk products is the process of heating every particle to at least 161°F and holding continuously for at least 15 seconds in approved and properly operated equipment; provided that products with higher milk fat content than milk and/or which contain added sweeteners shall be heated to at least 166°F for at least 15 seconds.

This section covers only the basic HTST installation and presents inspection guidelines for the several components; auxiliary equipment often synchronized into an HTST system is covered in the next succeeding section:

1 Raw Product Balance Tank (Float Tank)—This tank serves (a) to provide a constant supply of product for continuous operation, (b) as a reservoir for under pasteurized product diverted back into the system by the flow-diversion valve, (c) as a reservoir for temporary recirculation of pasteurized product when difficulties develop downstream from the HTST unit, and (d) as a reservoir for solutions used in cleaning and sanitizing operations.

Observe that the tank complies with sanitary construction requirements of Section A, and is completely covered except as necessary during operation. Also, that the overflow level of the tank is below the level of the lowest product passage in the regenerator (as subsequently discussed under regenerator pressure requirements).

The diverted flow line from the flow-diversion valve may enter the float tank at any point above the level of the milk. The by-pass pasteurized product line from the outlet of the HTST, as subsequently discussed, also may be connected to discharge back into the float tank, provided the arrangement is adequately protected against the possibility of backflow of raw product into the pasteurized product lines.

2 Heat Exchange System—Plate heat exchangers consisting of separate regenerative, heating, and cooling sections and mounted in a single frame or press are usually employed, although internal tubular types of heat exchangers are occasionally used. The three sections of the plate type heat exchangers need not necessarily be mounted in a single frame. Also, the cooling section may be subdivided into two consecutive stages, with refrigerated water (sweet water) as the cooling medium in the first, and a nontoxic refrigerant in the second stage. Occasionally, single or multi-stage open surface tubular coolers enclosed in a cabinet, or shielded, are used. While heating and cooling sections are necessary to comply with the requirements of the *Milk Ordinance*, a regenerative section is not mandatory, but is invariably used because of the economies it affords.

The flow-pattern of product in the basic HTST unit is by suction from the raw product balance tank through the raw side of the regenerator (where the raw product is heated and the pasteurized product cooled by counter currents on opposite sides of thin stainless steel plates) to the positive displacement timing pump which forces product through the heating section (hot water or steam-vacuum heating on opposing side), the tubular holder, the flow-diversion valve, and, if above pasteurization temperature, through the pasteurized side of the regenerator section and the cooling section (cooled indirectly by cold water or coolant) from which it passes to storage units to await packaging. Subtempera-

ture product is diverted by the flow-diversion valve back to the raw product balance tank for reprocessing.

Observe that the heat exchange units are of sanitary construction complying with the requirements of Section A, and that all gaskets are in good condition and adhere properly. Also, that the raw product side of the regenerator will drain back freely to the float tank when all pumps are stopped and the raw product outlet from the regenerator is disconnected. Compliance with this requirement, which relates to proper regenerator pressures as subsequently discussed, calls for the deflector plates in the lower raw product channel to be drilled with 1/16 inch holes, so that a continuous opening is available through the entire length of the channel, through which drainage may occur. Otherwise, the solid deflector plates would block drainage of all raw product lying beyond them and away from the raw product inlet (which is always at the bottom). An easy way to determine compliance is to loosen and partially open the press, and, beginning at the raw product inlet, determine that each successive solid plate encountered along the length of the channel (but not the plate at the end of the channel) has drilled holes as indicated. (In internal tubular types of regenerators the drainage requirement can be met by having the raw product channels slope continuously upward away from the float tank.)

3 Timing Pump—In the basic HTST unit the timing pump, which should be located downstream from the raw product outlet of the regenerative section, sucks the product through the regenerator and forces it at a controlled maximum speed through the heater, holding tube, and remainder of the HTST system. The controlled maximum speed has to be such that the required holding time will be assured under the fastest possible condition of flow, as determined under Test 11, Part II of this manual.

Observe that the timing pump is of the positive displacement type, of sanitary construction complying with the requirements of Section A, and is positioned and operating properly. Also, that the pump is identified as conforming to Test 11, Part II, and that the stop-setting on variable speed pumps is properly sealed; homogenizers used in lieu of a timing pump should also be identified as the actual equipment on which the timing tests were based. Timing pumps may be operated at any capacity less than their sealed maximum capacity.

4 Holding Tube—Observe:

a That the holding tube sizing and arrangement is the same as that used in the last official holding time determination

(Test 11, Part II) which gave a holding time of 15 seconds or more for every particle of product.

b That the diameter of the holding tube is seven inches or less, and free of any fittings through which the product may not be thoroughly swept (under these conditions, the holding tube design may be assumed not to have a simultaneous cross-sectional temperature difference exceeding 1°F between the hottest and coldest particles or product, as required by the *Milk Ordinance*).

c That the holding tube is installed so as to have a continously upward slope in the direction of flow of not less than ¼ inch per foot. This is to permit continuous purging of air and gases, which might otherwise affect the holding time. A spirit level should be used in checking slope initially, and when changes are made. Connections from the heater outlet to the holder inlet with less than ¼ inch per foot upward slope should not be considered as part of the holding tube; also, no part of the holding tube, except thermometer fitting openings, should be higher than the inlet connection to the flow-diversion valve (a downward slope between the end of the holding tube proper and the flow-diversion valve could also permit entrapment of air, which would shorten the holding time).

d That the supports for the installation are designed to maintain all parts of holding tubes in a fixed position, free from any lateral or vertical movement.

e That the installation is free of devices for short circuiting a portion of the holder to compensate for changes in rate of product flow; also that the holding tube is installed so that sections of pipe cannot be left out, resulting in a shortened holding time.

f That the holding tube is so designed and installed that no portion between the inlet and the temperature sensor for the recorder-controller is heated (otherwise, product could be at required pasteurization temperature but still not have been held continuously at that temperature for at least 15 seconds).

g That the holding tube is provided with fittings for installing an indicating thermometer and temperature sensor for the recorder-controller at the outlet end, and provisions made for the installation of a timing electrode adjacent to and upstream from the inlet. The indicating thermometer connection may be used for the other timing electrode, as called for in Test 11, Part II of this manual.

h That the holding tube conforms to the Sanitary Construction Requirements of Section A.

5 Bypass Valve and Line—(Note: The *Milk Ordinance* does not specifically require the facilities discussed under this heading, but they are essential to good operation and subsequent cleaning and bactericidal treatment of HTST equipment. When installed, they should, of course, conform to applicable sanitation requirements.)

The usual installation consists of a three-way valve installed in the pasteurized product discharge line from the cooling section of the HTST unit, as close as possible to and downstream from the opening to the atmosphere called for under heading number (10) Regenerator Pressure Requirements, which follows; a by-pass line is then connected to the three-way valve in such a manner that it may be swung so as to discharge either (a) into the top of the raw product balance tank, or (b) to waste on the floor. This facility may be used for passing rinse water, cleaning solution, or bactericidal solution during start-up, shut-down, or clean-up, or for the recirculation of pasteurized product.

In checking such a facility, observe:

a That the valve and line conform to the sanitary construction requirements of Section A.

b That the by-pass line is self-draining, and the manner of connecting into the float tank is such as to protect against any possibility of backflow of raw product into the pasteurized product lines. The line does not have to be disconnected from the float tank during operation, except as necessary for water diversion to waste during start-up and shut-down.

6 Indicating Thermometer and Temperature Sensor for Recorder-Controller

Observe that the indicating thermometer is in good repair and conforms to the specifications of the *Milk Ordinance*, page 149, and identify it as an instrument that has been tested and found to comply with Tests 1 and 7, Part II of this manual.

Observe that the temperature sensor (or bulb) for the recorder-controller which actuates the flow-diversion valve is located in the product line not more than 18 inches upstream from the flow-diversion valve, and that the indicating thermometer is located as near as practicable to the temperature sensor. Both should be in place in the product line continuously during the pasteurization process, and should not be influenced by or subjected to outside heat.

7 Recorder-Controller

The recorder-controller performs the important dual function of recording the time, temperature, and position of the flow-

diversion valve. Correct design installation and functioning of both is vital to effective control of the HTST process. Observe:

a That the recorder-controller is operating and in good repair with control settings sealed and conforms to the specifications of the *Milk Ordinance*, page 150; identify it as an instrument that has been officially tested and found to comply with Tests 2, 3, 4, 8, and 10, Part II, of this manual.

b That the temperature recording pen and the frequency pen for the diversion action are filled with ink and recording properly.

c That a new circular chart is used when operations exceed 12 hours in length.

d That the recording thermometer reads no higher than the indicating thermometer; if it does perform Test 4 as outlined in Part II of this manual.

e That the cut-in and cut-out points of the recorder-controller (Test 10, Part II) are both above the legal pasteurization temperature of 161°F. If not, make adjustments as outlined in Test 10, Part II.

8 Flow-Diversion Valve-Diverted Flow Line

Observe:

a That the flow-diversion valve is completely assembled, is operating properly, is in good repair and conforms to the specifications of the *Milk Ordinance*, page 74. Identify it as having been officially tested and found to be in compliance with the requirements of Test 5 (A, B, C, D, E), Part II of this manual.

During *forward flow* the (a) product pump should be running, (b) the green signal light should be on, (c) the air pressure should be on the diaphragm of the flow-diversion valve, without leaks and at a minimum pressure of 20 pounds per square inch, (d) the frequency pen arm on the chart should be in the forward flow position and in the proper time arc with respect to the recording pen.

During *diverted flow* the (a) product pump should be running, (b) the red signal light should be on, (c) the frequency pen arm should be in the diverted flow position, (d) no air pressure should be on the diaphragm of the flow-diversion valve.

b That the microswitch on the flow-diversion valve is correctly wired and properly positioned, by performing Test 5(C), as outlined in Part II of this manual.

c That no illegal auxiliary air or electrical connections have been made to the flow-diversion valve by means of which the valve can manually be made to assume the forward-flow position when product temperatures are sublegal.

d That the leak escapes on the flow-diversion valve are assembled and functioning properly, as evidenced by a normal instantaneous spurt of product during forward-flow-seat closure, followed by no excessive leakage; if abnormal operation is observed, perform Test 5(A), as outlined in Part II of this manual.

e That the diverted-flow line from the flow-diversion valve to the raw product balance tank is of sanitary construction, is self-draining, and is free of restrictions, unless they are so designed that stoppage of the diversion line cannot occur. Also, that partial restrictions placed in the diverted-flow line for the purpose of complying with Test 11, Part II, Holding Time, are in position during operation.

9 Recording Thermometer Charts

Examine recorder charts as completed by operator since last preceding official inspection. The charts should be completed with (a) date, (b) number of recorder-controller when more than one is used, (c) reading of indicating thermometer at a given time or reference point while the HTST unit is in forward flow, (d) amount and name of product represented by each run on the chart, (e) record of unusual occurrences, (f) record of the time during which the flow-diversion valve is in the forward-flow position, (g) the cut-in and cut-out product temperatures as determined daily by the operator, and (h) initials of operator and name of plant.

Record on current chart the results of cut-in and cut-out determinations and of the indicating thermometer reading made during the inspection and initial.

Discuss any inconsistencies or deficiencies noted during the chart examination with the operator and record results, including tests made during the inspection on the inspection form.

10 Regenerator Pressure Requirements

The *Milk Ordinance* requires that regenerators shall be constructed, installed, and operated so that pasteurized product in the regenerator will automatically be under greater pressure than raw product in the regenerator at all times.

In the basic HTST unit the timing pump is the only flow-promoting device and it is required to be so located as to suck raw product through the regenerator and force it under positive pressure through the remainder of the system, including the pasteurized side of the regenerator. The following conditions will assure proper regenerator pressures for the basic HTST unit (where certain auxiliary equipment is used, additional safeguards are necessary to assure compliance, as discussed under Section C(2) following).

a The overflow level of the raw product balance tank should be lower than the lowest product level in the regenerator.

b All raw product in the regenerator should drain freely back into the balance tank when the timing pump is shut-down and the raw product outlet is opened to the atmosphere.

c No pump or flow-promoting device should be located between the raw product balance tank and the inlet to the raw side of the regenerator (unless properly controlled as discussed under "Raw Product Booster Pumps," Section C(2), which follows).

d The pasteurized product, between its outlet from the regenerator and the nearest point downstream open to the atmosphere, should rise at least 12 inches above the highest raw product level in the system and should be continuously open to the atmosphere at this or a higher elevation. This requirement can be met by either an atmospheric free level tank or an approved sanitary type of vacuum breaker. The vacuum breaker should be upstream from any "can-off" lines, in order to avoid a possible siphonage effect.

e No pump or flow-promoting device which can adversely affect the proper relative pressure in the regenerator should be located between the pasteurized product outlet from the regenerator and the nearest downstream point open to the atmosphere. Here, an atmospheric free level tank would be necessary; a vacuum breaker will not suffice.

11 Heating and Cooling Medium Circuits

The *Milk Ordinance* does not specify any relative pressure requirements as between product circuits and the heating and cooling medium circuits. It is, therefore, necessary for both of these circuits to be protected against contamination which might enter the product through flaws in the partitions of the heat exchange system.

Water supplies used in both the heating and cooling systems should be from an approved source and protected from contamination. The water supply to make-up tank should be protected against backflow by an air gap of not less than two diameters (nominal pipe size), with a minimum of 1" or an acceptable vacuum breaker, or other effective backflow preventive device. Sanitary piping is not required, however, for connecting the heating and cooling medium units with the HTST pasteurizer.

Cooling may be done by any means such as water, brine, nontoxic freezing point depressants, or direct expansion of refrigerant, provided the product is protected against contamination. Recirculated cold water systems, including the storage tank, should be protected against contamination. Samples for bacteriological

examination should be collected semi-annually from such systems, and the results should comply with the bacteriological standards of appendix G, page 134, of the *Milk Ordinance*. When such systems become contaminated through repair work or otherwise, they should be given bactericidal treatment and tested before being returned to use. Freezing point depressants used in recirculating systems should be nontoxic. If the cooling medium is 32°F or lower, it is desirable, where possible, to provide means which will automatically control temperature of the coolant to prevent freezing of the product. This can also be controlled by automatically stopping circulation of the coolant when the flow-diversion valve assumes the diverted flow positions. These are not requirements of the *Milk Ordinance*, but are useful in facilitating operation.

Heating may be done by any means such as hot water, steam, electricity, or regeneration provided it is applied in such a manner as not to contaminate the product. A dependable thermostatic control of the heating medium is essential for satisfactory operation of the HTST unit. Cold sterilization switches can not be used.

C. HIGH-TEMPERATURE SHORT-TIME AUXILIARY EQUIPMENT

Various product processes synchronize well with the basic HTST pasteurization process, and may be incorporated into such units, subject to effective safeguards so that they (a) will not reduce the holding time below the legal minimum, (b) will not interfere with the detection of or stoppage of the forward flow of product which is below the legal pasteurization temperature, and (c) will not disturb the maintenance of the proper pressure relationships within the regenerator section. These processes and equipment include (1) homogenizers, clarifiers and separators, (2) auxiliary and raw product booster pumps, and (3) flavor control (vacuum-heat) equipment. Guidelines for inspection of these three categories of equipment are presented as follows: (Caution: Also make sure that the general hook-up and individual pieces of equipment are the same as when the tests described in Parts II and III were performed; otherwise, certain of these tests need to be remade.)

1 Homogenizers, Clarifiers, and Separators

a Homogenizers—There are many different hookups which include:

(1) Homogenizer of smaller capacity than pasteurizer and fed directly by Timing Pump—A relief line elevated above the inlet to the homogenizer or provided with a pressure relief valve,

shall be connected between the timing pump and the homogenizer to convey excess product back to the raw product balance tank. Also, an electrical interlock is required between the homogenizer and timing pump so that the former will stop when the latter stops; otherwise, the homogenizer could continue to cause flow through the holder under sublegal temperature if the flow-diversion valve did not assume the fully diverted position; a time delay relay not exceeding one second may be installed in the homogenizer starter circuit, so that the homogenizer will not shut down during the normal transit time of the flow-diversion valve. If adjustable, the relay should be set and sealed. The conditions of this paragraph apply whether the homogenizer is upstream or downstream from the heating section.

(2) Homogenizer of larger capacity than pasteurizer, and fed directly by timing pump.—Under these conditions an unobstructed recirculating loop of sanitary piping at least as large as the homogenizer inlet line must be installed between the inlet and outlet of the homogenizer to prevent "starving" of the homogenizer. This loop will recirculate all flow from the homogenizer when the timing pump is shutdown; an electrical interlock between the timing pump and homogenizer is, therefore, not necessary. However, if the loop line is smaller than the inlet line or includes restrictions, the interlock as discussed in the preceding paragraph is mandatory. The conditions of this paragraph apply whether the homogenizer is upstream or downstream from the heating section.

(3) Homogenizer used as timing pumps.—The homogenizer, when used in lieu of a timing pump, must be interwired with the flow-diversion valve so that it cannot operate at sublegal pasteurization temperature unless the flow-diversion valve is in the fully diverted position; a one second time delay relay may be installed as discussed in the second paragraph preceding.

(4) Homogenizer used as timing pumps only when homogenized product is being run.—Both the homogenizer and the timing pump must be interwired with the flow-diversion valve so that neither can operate at sublegal pasteurization temperature unless the flow-diversion valve is in the fully diverted position; a one second time delay relay may be installed for homogenizer starter, as previously explained.

(5) Homogenizer Downstream from Flow-Diversion Valve—When located downstream from the flow-diversion valve, the homogenizer must be placed in the pasteurized product line upstream from the inlet to the pasteurized product regenerator section, and in such a manner that it cannot apply

negative pressure at the forward flow seat of the flow-diversion valve nor decrease the holding time of the product within the holder.

These requirements can be considered as being satisfied when the homogenizer is of larger capacity than the maximum sealed capacity of the timing pump and is provided with an unobstructed recirculating loop of sanitary piping, at least as large as the homogenizer inlet line, installed between the inlet and outlet of the homogenizer. If a check valve is installed in this loop line, determine in a manner similar to that described in Test A, Part III, of this manual whether the operation of the homogenizer with the flow-diversion valve in diverted position, causes negative pressure at the forward flow outlet of the flow-diversion valve. If so, it would be necessary to take remedial steps such as changing the size or position of loop or check valve, or type of valve, or other appropriate measures to avoid the negative pressure. (NOTE: When flavor-control equipment as discussed under Section C(3), following, is installed between the homogenizer and the upstream flow-diversion valve, the foregoing provisions would nevertheless apply if there is a by-pass pipeline around such equipment or if a by-pass arrangement is sometimes used; otherwise, the provisions of Section C(3) would govern, and there would be no special requirements applicable to the homogenizer.)

b Clarifiers and Separators—Since both clarifiers and separators will not by themselves pump product, but actually exert a significant frictional resistance or back pressure while in operation, they are not flow producing devices and there is, therefore, no hazard involved in their continued operation when the timing pump is stopped in a high-temperature short-time system, into which either or both pieces of equipment have been synchronized. It is well, however, from the operational standpoint, to interwire both clarifiers and separators to the timing pump so that in case they stop (for any reason, e.g., fuse blowout) the timing pump will also stop. (Both of these pieces of equipment should be stopped during holding time tests, as discussed under Test 11, Part II of this manual.)

When placed adjacently downstream from the timing pump discharging to the heating section either a clarifier or separator may be connected directly to the raw product line (in this location a surge tank and auxiliary pump, as later discussed, is not necessary). Either cream or milk from a separator so situated may be reintroduced to the heating section by a direct sanitary line from the discharge of the separator so that either may be pasteurized.

When not placed adjacently downstream from the timing pump discharging to the heating section, separators shall be

placed downstream from the flow-diversion valve. They may be fed directly by the timing pump, when an auxiliary pump is not required, provided subatmospheric pressure is avoided at the inlet of the separator when it is running and the timing pump is stopped.

When a pump is required to feed separators downstream from the flow-diversion valve, there shall be a break to atmosphere, above the highest product level in the regenerator, between the take-off from the HTST unit and the pump. This break to atmosphere (or vacuum breaker) should be at the same elevation as that discussed under regenerator pressure requirements, Section B(10), preceding. Also, a float tank is needed between the vacuum breaker and the pump which supplies the separator. A sufficiently elevated float tank will obviate the need for the vacuum breaker. Both of these requirements relate to compliance with proper relative regenerator pressures, as discussed under Section B(10).

There is still another consideration, namely, the effect on holding time of the alternate flow path when the separator is used. This is covered under Test 11, Part II, of this manual. If a restriction is used in the line upstream from the separator, to equalize the flow times, it should be of a type whose omission can be determined without disassembly; otherwise, the timing pump can be sealed so as to give legal holding by the flow-path with the least back pressure.

2 Raw Product Booster Pump

A raw product booster pump may be installed in a conventional HTST pasteurization unit under safeguards as outlined in the *Milk Ordinance*, page 79, to assure that proper relative pressures are maintained in the regenerator section. Such pumps provide certain operating advantages including increased regenerator efficiency, maintenance of capacity during extended runs, and avoidance of excessive vacuum and subsequent "flashing" or vaporization of product in the regenerator section.

The safeguards in the *Milk Ordinance* require:

(a) A sanitary type centrifugal booster pump to be located between the raw product constant level tank and the inlet to the raw side of the regenerator and so interwired that it cannot operate unless (1) the timing pump is operating and (2) the flow-diversion valve is in the forward flow position, and (3) an automatic control device indicates that the pressure on the pasteurized side of the regenerator exceeds by at least one pound per square inch the maximum pressure developed by the booster pump. There are two general types of acceptable automatic control devices in

use, namely, pressure switch controls and time-delay controls, as discussed in Test 9, Part II of this manual.

(b) Sanitary type pressure gauges to be installed at the raw product inlet to the regenerator and at, or downstream from, the pasteurized product outlet of the regenerator. (When a dial-type pressure switch control is used, it may be considered as the pressure gauge at the regenerator outlet.)

A sanitary by-pass line may be installed around the raw product regenerator to facilitate and speed-up the starting operation. When installed, it should be of the shortest practical length, and run from the inlet line of the booster pump to the inlet line of the timing pump. It should be provided with a manual or automatic type valve, or a check valve, or other effective means to prevent entrapment of raw product at room temperature during normal operation.

In inspecting a booster pump installation observe that the pressure gauges are in position and are functioning, that the pressure control device is sealed, and that the entire set-up including arrangement and sizing and capacity of pump are the same as when Test 9, Part II, Setting of Controls for Regenerator Pressures, was last performed. Also perform Test 5B, Part II, by testing the manual diversion on the flow-diversion valve, to observe that the booster pump shuts down in diverted flow position.

3 Flavor Control Equipment

Flavor control equipment, including vacuum and steam-vacuum systems may, in accordance with the provisions of the *Milk Ordinance*, page 78, be installed and operated in conjunction with HTST pasteurization, under certain safeguards as discussed in Part III of this manual. That part of the manual discussed the different types of flavor control equipment and five tests (A, B, C, D, and E), that should be made initially, and at a suggested frequency of at least quarterly thereafter.

In making routine interim inspections of the equipment it is important to note that the hook-up and type of equipment is the same as when these tests were last performed, and that the units are functioning normally and satisfactorily. If any changes have been made, some of the tests may have to be repeated. Observe:

(a) That the seal on the ratio-controller setting is intact, and that the controller is maintaining the temperature differential for which it was set. (Test E)

(b) That in the case of vacuum equipment located downstream from the flow-diversion valve, the required vacuum breakers

and automatic check or positive type shut-off valve is in position upstream from the vacuum equipment (Test A) and also downstream (Test B), to prevent subatmospheric pressure at the flow-diversion valve and on the pasteurized product side of the regenerator.

(c) That the automatic steam control valve (Test C) is in position and functioning normally so as to shut-off the steam to steam-vacuum equipment when the flow-diversion valve assumes the diverted flow position.

(d) That, in case of direct type water-vapor vacuum condensers, the required automatic water shut-off valve and controls (Test D) are in position.

(e) That no toxic boiler compounds are in use for steam generated for direct injection into product.

Part VI—USEFUL RECORDS AND INFORMATION

A. SCHEMATIC RECORDS OF PASTEURIZATION INSTALLATIONS

It is desirable to maintain complete and accurate records of the pasteurization equipment installation at each milk plant for both the batch and high-temperature short-time processes. All test results, as previously discussed in this manual, should be recorded and placed in a separate file or record for each milk plant so that they are readily available when needed. In addition, it is desirable and almost essential to maintain a record of the actual processing equipment and hook-up at each plant. A convenient way to do this is to prepare a simple diagramatic sketch of the pasteurization installation at each milk plant, showing significant sanitation details such as make, model and serial numbers, sizes and/or capacities for each piece of processing equipment and appurtenances and the manner in which they are interconnected. An example of this type of sketch is shown in Figure 4. Such sketches will prove useful both in the office and in milk plants, particularly when changes in equipment or in hook-up are under consideration. New sketches should be prepared when significant changes are made in an installation.

B. USEFUL INFORMATION

Following are a few tables and charts of miscellaneous useful information related to problems which may arise in milk plants:

1. Certain comparative values of water, milk and cream.

Substance	Percent Butterfat	Percent Total Solids	Weight Per Gallon
Water	—	—	8.34
Skim Milk	0.20	8.20	8.64
Whole Milk	3.00	11.40	8.59
Whole Milk	4.00	12.30	8.61
Cream	20.00	27.13	8.43
Cream	40.00	45.35	8.28

2. Pipe and Fitting Capacities

a. Lengths of pipe having capacities of one gallon.

Diameter	Stainless Steel (outside diameter)	Glass (inside diameter)
1 inch	—	24'– 6.1" or 294.1"
1½ inch	12'–5.6" or 149.5"	10'–10.7" or 130.7"
2 inch	7'–0.1" or 84.1"	—

b. Capacities, in percentage of one gallon, in bends and elbows.

Diameter	Stainless Steel Bends	Glass Elbows
1 inch	—	1.98%
1½ inch	2.64%	5.02%
2 inch	6.60%	—

c. Cross-sectional area of stainless steel holding tubes.

Common Pipe Size	Actual Inside Diameter in Inches	Cross-Sectional Area In Square Feet
2 inch	1.87	0.0191
2½ inch	2.37	0.0306
3 inch	2.87	0.0449
4 inch	3.87	0.0817

d. Equivalent length of stainless steel 90° sweep elbows.

Diameter in Inches	Length Along Center Line in Inches
2	4.71
2.5	6.28
3	7.85
4	10.99

e. Equivalent capacities of stainless steel holding tubes of various sizes.

Desired Diameter In Inches	Actual Diameter in Inches			
	2	2½	3	4
2	—	1.602	2.351	4.277
2½	0.624	—	1.467	2.670
3	0.425	0.682	—	1.819
4	0.234	0.374	0.549	—

Example: 10 feet of 2 inch pipe = 10 x 0.234 or 2.34 feet of 4 inch pipe

3. Water—Pressure—weight equivalents

1 cubic foot of water = 7.48 gallons = 62.4 pounds

Head of water in feet x 0.433 = pounds pressure per square inch.

1 pound per square inch pressure = 2.3 feet of water column.

1 gallon water = 8.34 pounds = .13 cubic feet of water.

4. Relation of Pressure to the Boiling Point of Water

Vacuum Gauge Reading Inches	Boiling Point Water Deg. F.	Pressure Pounds Per Sq. In.	Vacuum Gauge Reading Inches	Boiling Point Water Deg. F.	Pressure Pounds Per Sq. In.
0	212.0	14.696	22.5	149.2	3.396
1	210.2	14.206	23	147.2	3.396
2	208.6	13.716	23.5	143.4	3.156
3	207.0	13.226	24	140.4	2.906
4	204.8	12.736	24.5	136.9	2.666
5	203.0	12.236	25	133.2	2.416
6	201.0	11.746	25.5	129.2	2.176
7	198.9	11.256	26	124.7	1.926
8	196.7	10.766	26.5	119.7	1.676
9	194.5	10.276	27	114.1	1.436
10	192.2	9.786	27.5	107.6	1.186
11	189.7	9.296	28	99.9	0.946
12	187.2	8.806	28.2	96.1	0.846
13	184.6	8.316	28.4	92.1	0.746
14	181.8	7.816	28.6	87.8	0.646
15	178.9	7.326	28.8	82.6	0.556
16	175.8	6.836	29.0	76.5	0.456
17	172.6	6.346	29.1	73.2	0.406
18	169.0	5.856	29.2	69.3	0.356
19	165.2	5.366	29.3	64.9	0.306
20	161.2	4.876	29.4	59.9	0.256
20.5	159.1	4.626	29.5	54.1	0.206
21	156.7	4.386	29.6	46.9	0.156
21.5	154.4	4.136	29.7	37.0	0.106
22	151.9	3.886	29.74	32.0	0.086

Perfect vacuum = 29.921 inches of vacuum
= 14.696 lb.-per-sq.-inch reduction in pressure

To convert inches of vacuum to pounds pressure, use formula:

$$\text{Pounds per square inch} = \frac{14.696 \times (29.921 - \text{Inches vacuum})}{29.921}$$

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DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE

MILK PLANT EQUIPMENT TESTS REPORT

TEST NO.	TEST	FREQUENCY (In addition to initial test)	SEE ORDINANCE PAGE	TEST MADE (✓)	IDENTITY OF EQUIPMENT AND RESULTS OF TEST
1	Indicating thermometers (including air space thermometers): Temperature accuracy.	Quarterly	154		
2	Recording thermometers: Temperature accuracy	Quarterly, and when frequent adjustments necessary.	155		
3	Recording thermometers: Time accuracy	Quarterly	156		
4	Recording thermometers: Checked against indicating thermometer	Quarterly (daily by operator)	156		
5	Flow diversion valve: Proper assembly and function	Quarterly	157		
	A. Leakage past valve seat		157		
	B. Operation of valve stem		157		
	C. Valve assembly		157		
	D. Manual diversion		158		
	E. Response time		158		
6	Leak-protector inlet, outlet, and diversion valves: Leakage	Quarterly	158		
7	Indicating thermometers on pipelines: Thermometric response	Quarterly	159		
8	Recorder-Controller: Thermometric response	Quarterly	159		
9	Setting of controls: Regenerator pressure	Quarterly; after any change in booster pump or switch circuit, and/or whenever switch seal is broken.	160		
	A. Pressure switches used to control operation of booster pumps		160		
	B. Time delay switches used to control operation of booster pumps		161		
	C. Pressure gages: Accuracy	Quarterly; and following repair or adjustment.	162		
10	Milk-flow controls: Cut-in and cut-out temperatures	Quarterly (daily by operator)	162		
11	Continuous flow holders: Holding time	Semi-annually; and whenever any alteration is made.	163		

REMARKS:

PLANT	LOCATION	DATE	SANITARIAN

NOTE.—This form is a supplement to the Milk Plant Inspection Report FDR-729-1, and these tests are in addition to the equipment requirements for which compliance is determined by inspection. See Appendix I, Grade A Pasteurized Milk Ordinance—1965 Recommendations of the U.S. Public Health Service.

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Figure 3. Milk Plant Equipment Tests Report

SUPERIOR DAIRY

Anytown, Anystate

SCHEMATIC RECORD OF HTST INSTALLATION

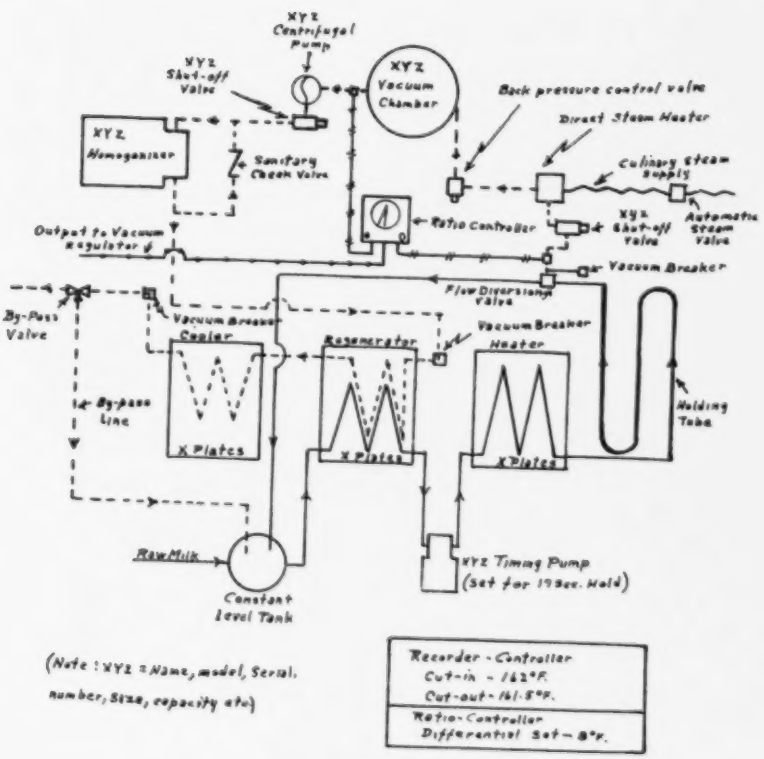

Figure 4. Schematic Record of HTST Installation

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